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Weapon-System-Oriented Supply Management at DLA: Relating Inventory Investment to Readiness

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PREFACE

In this report, we recommend seven specific actions the Defense Logistics Agency (DLA) can take to better relate wholesale inventory investment to weapon system readiness. For quick reference, the seven recommendations are summarized in the appendix at the end of the report.

This work builds on earlier Logistics Management Institute (LMI) research on how DLA's supply performance affects readiness. We extend previous results concerning DLA's effect on Air Force readiness to all the Military Departments, and we validate and deepen earlier findings on opportunities for DLA improvements.

As in the case of the earlier work, the report will be of interest primarily to supply managers and policy makers charged with implementing "secondary item weapon system management" in the DoD supply system.

This work would not have been possible without the assistance of Tovey Bachman and Christo Andonyadis at LMI. Wayne Faulkner, Lt Col Jeff Bailey, and Chief Master Sergeant Rosemary Johnston of the Air Force Logistics Management Agency in Montgomery, Alabama, provided critical retail data. Lud Coco, Mike Pouy, Lt Col Andrew Ogan, and Jeff Goldstein at DLA Headquarters provided the appropriate mix of support, patience, and advice to keep the work on track. Tom Lanagan, Rick Baker, Ben Roberts, and Aubrey Hudgins at DLA's Operations Research Office (DORO) in Richmond, Virginia, once again, as they have in the past, provided both data and helpful analytical support.

LMI

Executive Summary

WEAPON-SYSTEM-ORIENTED SUPPLY MANAGEMENT AT DLA: RELATING INVENTORY INVESTMENT TO READINESS

The Defense Logistics Agency (DLA) – DoD's primary wholesale supplier of consumable secondary items – can improve its contribution to weapon-system readiness while still controlling costs. Improvements are possible in two key areas:

- In the treatment of first-indenture weapon-system consumables
- In the treatment of *all* DLA-managed consumables (weapon-system and otherwise, without regard to indenture) when wholesale safety level requirements are computed.

First-indenture weapon-system consumables [i.e., line replaceable units (LRUs) that happen to be consumables] are particularly important because

- Consumable LRUs have greater leverage on readiness than do DLA items in general. (This confirms what common sense says should be true, as well as earlier, model-based results indicating that consumable LRU effects on weapon-system readiness are greater than "awaiting parts" effects.)
- Consumable LRUs are not numerous in comparison to the total number of DLA weapon-system items [probably representing no more than 10 percent of the roughly 400,000 demand-based items currently in the DLA Weapon System Support Program (WSSP)].

These findings suggest that by holding safety levels either constant or increasing them slightly for LRUs while decreasing them somewhat for other items, DLA can reduce replenishment costs overall while maintaining support for readiness. The "item essentiality" factor already available for use in the safety level formula in DLA's Standard Automated Materiel Management System (SAMMS) provides the necessary mechanism.

To do this, DLA must find and identify the consumable LRUs among the millions of items it manages. We found that consumable LRUs can be satisfactorily identified through the use of *existing* logistics data, without having to construct new

data elements and files. Standard, DoD-wide Source, Maintenance, and Recoverability (SMR) codes, in combination with available indenture codes, can satisfactorily identify the consumables that serve as LRUs, or, as they are called in the Navy, weapon replaceable assemblies (WRAs).

The last point is important for DLA's work with the Joint Logistics Systems Center (JLSC), which is attempting to define the capabilities required in DoD's current and future logistics data processing systems. It suggests that for managing consumables, there is no need to go through the difficult, time-consuming, and expensive effort of constructing and maintaining detailed weapon-system application and indenture files. Rather, it would be better to build a system for extracting existing SMR codes and indenture data for consumables and putting those data to work as part of DLA's item classification process.

The Defense Logistics Agency should begin the process of focusing on consumable LRUs by taking formal steps with the Services and the JLSC to obtain SMR and indenture data for all DLA-managed items, demand-based and otherwise, without regard to whether the items are currently in the WSSP. We recommend that DLA begin using those data to identify consumable LRUs and that DLA consider reclassifying weapon-system items as "most essential" (for purposes of system safety level calculations) only if they are consumable LRUs.

We found, also, that by revising some of the current rules for computing item safety levels at the hardware centers for *all* demand-based items (not just consumable LRUs), DLA has another opportunity to reduce costs while improving supply performance.

Currently, each DLA supply center performs a single system safety level calculation for its *entire* collection of demand-based items – weapon-system and otherwise. That calculation has as its goal minimizing the average number of outstanding *requisition* backorders. Procedures exist within SAMMS for giving some items a higher safety level (e.g., use of item essentiality codes and "augmented" safety levels for weapon-system items), but such procedures are expensive, inefficient, and often ineffective.

Alternatives for revising system safety level calculations in SAMMS involve

- Resizing system backorder targets to more realistic levels.
- Considering the benefits of using *unit*-oriented as opposed to requisition-oriented backorder targets. (A backordered requisition for 10 items would represent 1 requisition backorder but 10 unit backorders.)
- Iterating safety level calculations to reduce the suboptimizing effect of safety level constraints.
- Grouping items differently when system calculations are performed.

The first three ideas are related and involve rethinking what has been the traditional DoD wholesale supply policy to minimize "time-weighted requisitions short." Under that policy, as implemented at DLA's Defense General Supply Center (DGSC), the following situation existed at the end of March 1992: with slightly over $300 million in safety level requirements on its books, DGSC could project an average of 2.1 million wholesale unit backorders to be outstanding at any given time (the actual number of outstanding unit backorders at DGSC at the end of March 1992 was just under 3.4 million). We estimate that, by making the three changes noted, DGSC could reduce its aggregate safety level requirement to $54 million while simultaneously reducing expected outstanding unit backorders to less than 2.0 million.

The final idea, that of grouping items differently, arises from a fundamental fact about weapon-system-oriented supply management: projecting the effects of supply performance on a given weapon system's availability is a central goal. *The first necessary step for doing that is to focus on the group of items that make up the system.*

For DLA, the problem will be to find, when computing safety levels, the right balance between weapon-system grouping and the current method of commodity grouping. The mathematics of system optimization implies that safety levels under large-scale commodity grouping will always be cheaper overall than those computed under weapon-system grouping. But as the shift to weapon-system-oriented supply management continues, DLA probably cannot avoid some form of weapon-system grouping. The most practical way for DLA to proceed would be to group WSSP and non-WSSP items separately in system safety level calculations. That would accommodate the move to weapon-system-oriented management while preserving the benefits of large-scale optimization.

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CHAPTER 1

OVERVIEW

MEETING THE CHALLENGE OF WEAPON-SYSTEM MANAGEMENT

The central mission of the Defense Logistics Agency (DLA) is to serve as DoD's wholesale-level agent for acquiring, managing, and distributing fuel, food, clothing and textiles, medical materiel, and consumable-type hardware in the commodity categories of general, industrial, construction, and electronics items. In performing its supply management mission, DLA has two jobs: to be as frugal as possible in what it spends to operate and maintain inventories and, simultaneously, to provide the appropriate level of wholesale supply support that its retail-level military customers need to operate, train, and be ready to fight.

Over the years, DLA has developed the Standard Automated Materiel Management System (SAMMS) to support its supply management mission. For consumable hardware items, SAMMS employs well-established methods for large-scale inventory optimization (i.e., setting stock levels to minimize inventory ordering and holding costs, subject to a targeted level of supply performance).

Against this backdrop, "secondary item weapon-system management" is being promoted throughout DoD as one of the ways supply managers can control inventories and reduce spending while meeting military objectives. Given its special role as DoD's wholesale manager for hardware consumables, DLA faces the fundamental challenge of how best to accommodate the new weapon-system-oriented ideas while preserving the opportunities for cost savings inherent in its traditional, large-scale, commodity-oriented methods for wholesale inventory management.

This report, which builds on the results of earlier Logistics Management Institute (LMI) research [1], offers DLA a way to meet that challenge.

The Defense Logistics Agency does *not* have to make radical changes in its approach to wholesale inventory management *in order to provide better support to* readiness while reducing costs. By identifying and emphasizing safety levels for the items with the greatest leverage on readiness, and by making reasonable revisions in

the way items are grouped when computing system safety levels (both of which procedures can be accommodated using mechanisms already existing in SAMMS), DLA can conform to the spirit and intent of weapon-system-oriented supply management without having to fundamentally alter its basic approach to consumables management.

Under DoD's Corporate Information Management (CIM) initiative for materiel management, DLA is working with the Services at the CIM Joint Logistics Systems Center (JLSC) in Dayton, Ohio, to incorporate secondary item weapon-system management and other new management ideas into a single "standard" logistics system for the future.

So far in the JLSC effort, DLA has indicated that it plans to do secondary item weapon-system management in a *reactive* way, by setting levels on the basis of information to be generated and provided by the Services on required wholesale supply response times for weapon-system items. Under that approach, DLA (ultimately) gives up at least some – if not all – control over the setting of wholesale stockage requirements for weapon-system items. The Services, for their part, have to spend time and money to give DLA the required information.

Alternatively, DLA could choose to pursue "business process improvements" to provide better support to weapon systems in a *proactive* way, using the ideas presented in this report. Although transmission of some information from the Services to DLA is still necessary, that information [Source, Maintenance, and Recoverability (SMR) codes and related data] already exists in Service data systems, so the problem is more one of making existing systems communicate better than it is of building new files and systems.

Given the size of DLA hardware supply operations (over $2.0 billion per year in replenishment costs alone), and the fact that SAMMS is expressly designed to work with consumable economic order quantity (EOQ) items, a case can be made that many basic SAMMS procedures should be preserved. The case gets stronger if weapon-system management benefits are achievable within existing SAMMS structures. It gets stronger still if a proactive approach ultimately will cost DoD and the Government less than other, more ambitious system development alternatives.

The chapters that follow present evidence that a proactive approach can work. Each chapter offers findings and recommendations for DLA action. After the recommendations are general comments on management ramifications.

A NOTE ON COSTS

This report is about how DLA can improve its contribution to weapon-system readiness while controlling costs. The costs to be controlled are stock replenishment costs at DLA's four hardware supply centers, which serve as wholesale inventory control points for consumable-type industrial, general, construction, and electronics items. The four centers already manage about 3.0 million distinct line items [*national stock numbers* (NSNs)] and are in the process of assuming management responsibility from the Services for roughly a million more. The additional items are being assigned to DLA under the DoD Consumable Item Transfer program, a Defense Management Review initiative that will make DLA the wholesale manager for virtually all consumables in the DoD logistics system.

At the centers, stock replenishment decisions and costs are influenced by item reorder points. As an item experiences demand, the "inventory position" (i.e., the total number of assets on hand plus those on order minus any outstanding backorders) is periodically compared to the reorder point to determine whether a replenishment order needs to be placed. If a replenishment order is placed, and the reorder point has been *raised,* all consumed stock will be replaced and *additional* stocks ordered. If, however, the reorder point has been *lowered,* some of the consumed stock will not be replaced. It is in the latter case that a savings will be realized in replenishment costs.

For demand-based items (i.e., items with enough recent demand history to support demand projections and inventory calculations), reorder points are the sum of expected leadtime demand plus a safety level. DLA is already working on ways to reduce leadtimes. Lowering safety levels is another way to lower reorder points and save on replenishment costs over time.

In this report, we look at safety levels. In discussing both consumable line replaceable units (LRUs) and system safety levels, the central idea is that by changing the *mix* of item safety levels at the hardware centers – more safety level for some items, less for others – DLA can reduce its *overall* hardware-item replenishment costs while maintaining or improving its contribution to readiness.

CHAPTER 2

CONSUMABLE LRUs

BACKGROUND

This chapter is about first-indenture consumable hardware items – what they are, how DLA can identify them, their effect on readiness, and what DLA should do about them.

By "first-indenture consumables" we mean consumables that apply *directly* to weapon systems rather than consumables that are repair parts for other, higher indenture components. We will call such first-indenture consumables "consumable LRUs." The term "LRU" is used by the Army and Air Force and stands for "line replaceable unit." The corresponding term in the Navy is "WRA," which stands for "weapon replaceable assembly."

Note that the definitions of LRU and WRA *do not require that the item in* question be a *reparable*-type secondary item, even though traditionally the terms have been used that way. All that is really required is that organizational-level maintenance personnel have access to the item on the weapon system and be able (and authorized) to remove and replace it when necessary. By organizational-level ("O-level") maintenance personnel, we mean people who work *directly* on weapon systems – e.g., people who work directly on aircraft on the flightline at Air Force bases (AFBs) and naval air stations, or who work directly on aircraft and installed weapon systems aboard ship, or who have organizational-level/operator-level maintenance responsibilities for combat systems in the Army. The items these people remove and replace are not always items subject to repair; sometimes they are consumables. Our use of the term "consumable LRU" is deliberate, therefore, to emphasize that, like reparables, consumables too can be WRAs and LRUs.

A consumable LRU is important for the same reason any LRU is important: If an LRU on a weapon system fails or otherwise needs to be replaced, a "hole" will exist on the weapon system until line (organizational-level) maintenance personnel can obtain a serviceable spare from supply. If supply cannot produce the part, the weapon system is very likely to be classified as not mission capable-supply (NMCS) or

partially mission capable – supply (PMCS), and a direct readiness effect is felt. If, however, the item is not an LRU but a repair part for some other component, the readiness of the weapon system will not be affected if a spare for the parent component is available.

Of course, this is not to say that repair parts are not important, too. Adequate supplies of repair parts are needed to help keep broken components moving through depot-level and intermediate-level repair pipelines, whether or not weapon systems happen to be waiting. But, given the large number of spares in circulation, when entire weapon systems find themselves waiting on supply, they will usually be waiting for an LRU rather than for a repair part (unless LRU spares are in extremely short supply – in which case the weapon system could be waiting for the repair of a component that is itself waiting for a part).

This view of the role of reparable LRUs and their interaction with repair parts is central to all of the "multi-indenture" weapon-system-oriented supply models developed for the Army, Navy, and Air Force over the last 20 years. Every one of those models, when computing a *weapon system* availability rate, focuses in its final calculations on the particular set of WRAs or LRUs that make up the system. As DLA addresses the question, therefore, of how to perform secondary item weapon-system management, the idea that it should pay special attention to consumable LRUs is a natural development.

The reasoning above says that consumable LRUs are important because, by their nature, they should have greater leverage on readiness than non-LRU consumables do. Logically, that follows, but to what extent is it true in actual practice? In particular, how many consumable LRUs are there, and how much greater is their real influence on readiness? Answers to these practical questions are important if DLA is going to single out consumable LRUs for special treatment – something DLA has never done in the past.

Our earlier research [1] provides some clues. Based on wholesale DLA data, retail-level Air Force data, and calculations with the Air Force Aircraft Availability Model (AAM), a rule of thumb developed in the earlier research implies that changes in outstanding DLA wholesale unit backorders for consumable LRUs have 10 to 15 times the effect on weapon-system NMCS and PMCS rates that changes in outstanding wholesale unit backorders for consumable repair parts have.

The rule of thumb was derived in three steps. First, we observed two real-world quantities: the number of outstanding DLA backorders and the existing NMCS and PMCS rates for aircraft. We then made a simple linear projection to estimate how NMCS and PMCS rates would change if DLA backorders were to increase (holding everything else in the logistics system constant). We then used the AAM to see what portion of the total change in NMCS and PMCS rates could be attributed to "awaiting parts" (AWP) conditions in repair caused by backorders for consumable repair parts. In effect, we used the AAM to estimate the extent to which Air Force spares levels for *reparables* buffer aircraft from feeling the effects of delays in obtaining *consumable* repair parts.

The drawback of this approach is that it does not measure consumable LRU effects directly. Rather, it obtains them indirectly, by subtracting AWP-caused effects from total NMCS and PMCS effects and attributing the difference to consumable LRUs.

Still needed, therefore, is *direct* verification (by observation, if possible, without using a model) that consumable LRUs really do have greater leverage on readiness. Obviously, to obtain that verification, we must first be able to identify which consumables are the consumable LRUs.

For identification, we use SMR codes, which are standardized DoD data elements [2] defined for item/weapon-system combinations. The third and fourth positions of the six-position code provide the maintenance information. The third position (the one we are interested in) tells the lowest level of maintenance authorized to remove and replace the item on the weapon system. In particular, the presence of the letter "O" means organizational-level maintenance personnel can (and may) remove and replace the item. Thus, consumable-type weapon system items with an "O" in the third position of the SMR code are candidates to be consumable LRUs for that weapon system. (The fourth-position maintenance code tells whether the item itself is subject to repair and, in that case, the lowest level of maintenance capable of performing the repair.)

A problem is that the third-position SMR maintenance subcode is not captured or stored in DLA data systems. It was necessary, therefore, to find sources for SMR codes for item/weapon-system combinations and link them with DLA data.

The sections that follow describe data systems in the Air Force, Navy, and Army that contain SMR information for item/weapon-system combinations. We begin with the Air Force because it is there where we have additional information on the extent to which SMR codes provide *reliable* indicators of whether consumable items are consumable LRUs or not. In the context of the recommendations about using SMR data, the accuracy of those data is clearly an important issue. What we learned in the Air Force is important for DLA to keep in mind as it approaches the Navy and the Army for SMR and related data.

Following the Air Force discussion, the sections for the Navy and Army provide the names and brief descriptions of the data systems in those Services that contain SMR codes and related data, akin to what we found in the Air Force. Point-of-contact offices in the Navy and Army are provided for obtaining further information.

IDENTIFYING CONSUMABLE LRUs USED BY THE AIR FORCE

SMR Codes and Indenture Data

To obtain SMR information from the Air Force, we used the Air Force's Master Materiel Support Record (D049) system [3], which at the time of this study was the Air Force's "bill of materiels" system for depot level maintenance.[1] Quoting from the introduction to the D049 manual

> *The Master Materiel Support Record (MMSR) system maintains current identification of parts and materiels which are part of end items subject to depot level repair. The equipment specialist is responsible for the development and file maintenance of the MMSR.*

We used D049 records from March 1989. The Air Force supplied the records on tape to the DLA Operations Research Office (DORO) in Richmond, Virginia, in 1989. Following instructions from the Operations Research and Economic Analysis Office at DLA Headquarters, DORO transferred the tapes to LMI in March 1991.

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[1]While this study was in progress, the Air Force discontinued the D049 system and replaced it with the Application Program Indenture (API) system, part of the Air Force's Requirements Data Bank (RDB) system. Like the D049 system, the API system can provide SMR information for an item/weapon-system combination. Although we did not verify the API system's ability to provide additional indenture information to confirm SMR data (like the D049 indenture code described in the text), the office at Air Force Materiel Command (AFMC) with functional responsibility for the API system stated that Next Higher Assembly (NHA) information could be extracted for consumable items. Points of contact for the API system are Mr. Jeff Bobbitt or Mr. Laurence Brett, HQ, Air Force Materiel Command (AFMC/XRII), Defense Switched Network (DSN) 787-5313.

The D049 system contains two types of records: end-item records and component-item records. End-item records provide information on the end items subject to depot repair covered by the D049 system; component-item records provide information on the components that apply to those end items. The March 1989 data we used contained more than 7 million component-item records.

In the D049 system, component-item records are linked to end items by means of a D049 "control number" assigned to each D049 end item. If an NSN applies to an end item, a component-item record for that NSN linking the NSN to the end item will exist in the D049 system. The record will contain the component item's NSN, the control number for the end item to which the NSN applies (thereby making the link), the SMR code for the NSN in relation to the end item, and other data about the NSN, *including* a D049 "indenture code" describing the "relationship of the component item to the end item or system" (quoting from the D049 manual).

The single-character alphabetic indenture code in the D049 system is defined in *exactly* the same way as the indenture code defined in the Military Standard (MIL-STD-1388-2A and MIL-STD-1388-2B) Logistics Support Analysis Record (LSAR) [4]. Thus, a "B" in the indenture code field on a D049 component-item record means that the NSN on the record is a first-indenture component on the end item identified by the control number on the record. If that control number is the control number for a weapon system (e.g., an F-15 aircraft), the item is a first-indenture item on that weapon system.

Thus, for the item/weapon-system combination represented by the record, the indenture code provides an internal validity/consistency check on the maintenance information appearing in the third position of the SMR code.

We chose the F-15 weapon system to test whether it is possible to identify consumable LRUs for a given weapon system. Using D049 end-item control numbers for the F-15A, F-15B, F-15C, and F-15D, we found the following:

- 178,529 component-item records for F-15 components
- 19,851 distinct NSNs among the 178,529 records[2]
- 4,708 of the 178,529 records with
  - Source of supply equal to "S9I," "S9C," "S9G," or "S9E" (codes for DLA's four hardware supply centers)
  - Third position of the SMR equal to "O"
  - Indenture code equal to "B"
- 1,834 distinct NSNs among the 4,708 records.

The final set of 1,834 NSNs became our candidate set of DLA-managed consumable LRUs for the F-15.

Consumable LRUs are supposed to be identifiable using SMR codes. Why did we also use indenture codes in the search? Because, unfortunately, the reliability and accuracy of the maintenance information provided by SMR codes cannot always be trusted. Although the SMR regulations give a seemingly straightforward description of the maintenance information provided by SMR codes, evidence from a variety of sources suggests that SMR maintenance data are not uniformly reliable. The Air Force D049 records themselves provide a good example of the problem.

[2]The D049 manual states that "the design of the MMSR system prohibits the same component item (NSN and part number) from being entered more than once under the same control number." Given that policy (which makes sense), readers may be justifiably puzzled why there are so many more component-item records than there are distinct NSNs. Even if each of the 19,851 NSNs applied to each of the four versions of the F-15, that would yield only about 80,000 component-item records. Many of the additional records exist as the result of a problem that arose in 1986 and 1987 when large numbers of NSNs were "lost" in the Air Force base cataloging (D046) system. That led to D049 records with blanks in the NSN field, because NSNs on D049 records are (were) obtained from an interface with the D046 system. In the March 1989 data we examined, more than 122,000 F-15 component-item records are blank in the NSN field. Notice that the number of distinct NSNs identified as candidate consumable LRUs on the F-15 (1,834 NSNs) is logically more consistent with the number of consumable LRU F-15 component-item records (4,708 records), implying many of the 1,834 NSNs apply to more than one version of the F-15.

Relaxing the indenture code criteria and simply requiring an "O" in the third SMR position yields 4,003 distinct NSNs as candidate F-15 consumable LRUs. That is 2,169 more NSNs than the 1,834 we found using the SMR and indenture codes together. The "O" in the third SMR position indicates that the 4,003 NSNs can be removed and replaced on the F-15 by organizational-level (i.e., flightline) maintainers. Only 1,834 of those NSNs, however, are first-indenture items on the F-15, according to the indenture codes. That does not make sense. As defined, F-15 items with an "O" in the third SMR position should either be identical with – or possibly, a proper subset of – the items identified as first-indenture by the indenture code. (They could be a proper subset because some F-15 first-indenture items, for physical or other reasons, might not be removable and replaceable by flightline maintainers. If, however, an item *can* be removed and replaced on an F-15 by *flightline maintenance personnel, it certainly qualifies as a first-indenture item on* the aircraft.)

Thus, the evidence is that SMR codes by themselves – because of vagaries in the data or in the way the data have been assigned by various equipment specialists operating under different instructions over time – are not completely reliable for identifying consumable LRUs.

That, of course, raises the legitimate question: why believe that combining the SMR code with another code does a better job?

A Real-World Test

To test our set of 1,834 candidate F-15 consumable LRUs, we posed the following question: has the set of 1,834 items had noticeably more impact on F-15 readiness than F-15 consumable items in general have had? We present evidence below that they have, using data from two Air Force F-15 bases, Langley AFB in the United States and Bitburg AFB in Germany. We show that the 1,834 items are statistically more likely to have grounded aircraft than have the population of DLA items in general.

Since 1987, Standard Base Supply System (SBSS) records at Air Force bases have included a data element called a Mission Impact Code (MIC) (pronounced "mike") for each item on the base stockage list ([5], [6]). Developed to identify "high mission impact" items, the codes are assigned on the basis of Urgency of Need Designators (UNDs) codes defined in the DoD Uniform Materiel Movement and Issue

Priority System (UMMIPS). Customers must use UND codes when they place issue requests on base supply. If base supply cannot fill the request, the UND codes are used to assign UMMIPS priorities to the off-the-base requisitions that will be generated to obtain the needed items. If the base stocks the item, requisitions may already exist in the form of replenishment requisitions whose priorities must be upgraded. If the base does not stock the item, the issue request will cause a new requisition to be created.

A MIC value of "1" indicates that at some point in the item's history at the base, lack of the item either

- grounded a weapon system [i.e., rendered an aerospace vehicle not mission capable (NMC) or partially mission capable (PMC) with highest possible UND], or

- caused an AWP condition on a component in repair, again with highest possible UND associated with the request for the repair part [i.e., lack of the component was grounding a weapon system (so no spares for the component were available), and the component itself could not be repaired because it was awaiting the item repair part].

Out of the 1,834 NSNs from March 1989 D049 records, 565 NSNs were stocked at Langley in the latter half of 1991. A total of 249 (44.1 percent) were MIC "1" items. This figure compares to a total of 24,803 DLA-managed NSNs at Langley in 1991, of which only 8,747 (35.3 percent) were MIC "1" items. At Bitburg, we matched 499 NSNs, of which 221 (44.3 percent) were MIC "1," compared to a total of 21,901 DLA-managed NSNs at Bitburg in 1991, of which only 5,933 (27.1 percent) were MIC "1" items.

Statistically, these data lead us to reject the hypothesis that the set of 1,834 items has the same effect on F-15 readiness as do F-15 consumable items in general. We accept the alternative hypothesis that they have greater influence, as

measured by the relative frequency of items that have actually grounded weapon systems.[3]

The preceding result does not prove that we have captured all the higher leverage F-15 consumables in the group of 1,834 items. However, running the same tests on the larger set of 4,003 items obtained using SMR data alone yields mixed results, suggesting that SMR data by themselves are not enough to identify the high-leverage items.

Out of the set of 4,003 NSNs, 1,239 NSNs were on a March 1990 stockage list from Langley. Of those 1,239 items, 426 (34.4 percent) were MIC "1" items. That proportion is sufficiently greater than the general proportion in March 1990 at Langley (29.2 percent[4]) to cause us to accept the hypothesis that the set of 4,003 items has greater leverage. But at Bitburg, where 1,043 of the 4,003 NSNs were stocked in March 1990, only 210 of the 1,043 (20.1 percent) were MIC "1" items. That figure (20.1 percent) is *not* sufficiently greater than the general proportion in March 1990 at Bitburg (18.6 percent) to justify the conclusion that the 4,003 items are special.

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[3]Our hypothesis test is a one-tailed test of the difference between two proportions:

$$H_0 : p_2 = p_1 \ (\textit{the null hypothesis}); \ H_1 : p_2 > p_1 \ (\textit{the alternative hypothesis})$$

where p_2 denotes the relative frequency of MIC "1" items among the 1,834 F-15 consumable LRUs, and p_1 denotes the relative frequency of MIC "1" items among F-15 consumables in general. We make the standard assumption that

$$z = \frac{\bar{p}_2 - \bar{p}_1}{\sqrt{\bar{p}(1 - \bar{p})\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} \ \textit{with}\ \bar{p} = \frac{n_1\bar{p}_1 + n_2\bar{p}_2}{n_1 + n_2}$$

has an approximate N(0,1) normal distribution, where $\bar{p}_2$ denotes the sample estimator of the relative frequency of MIC "1" items among F-15 consumable LRUs and $\bar{p}_1$ denotes the sample estimator of the relative frequency of MIC "1" items among F-15 consumables in general. The values n_1 and n_2 are sample sizes. At the .05 significance level (i.e., 95 percent confidence that our conclusion is correct), we reject H_0 and accept H_1.

[4]In March 1990, Langley had 21,717 DLA-managed NSNs, of which 6,337 (29.2 percent) were MIC "1" items. Bitburg had 20,077 DLA-managed NSNs in March 1990, of which 3,731 (18.6 percent) were MIC "1" items. Alert readers will notice that among consumables in general at the two bases, the proportion of MIC "1" items was greater in the latter half of 1991 than it was in March 1990. The increases are a reflection of the fact that MIC values tend to "migrate" toward a value of "1" over time – because MIC values are never downgraded in base supply files in the Air Force.

On the other side of the question of whether the set of 1,834 items is too small is the question of whether that set is still too large. In particular, is it possible that a *smaller* set of items, within the 1,834 we identified, has even greater leverage on readiness? If that were the case, *those* items might be the "true" consumable LRUs. To answer this question, we took one more step with the D049 records.

Among the entire set of more than 7 million D049 component-item records, 49,426 records contained one of the 1,834 NSNs. Of those 49,426 records, 43,722 were headed by an end-item control number different from the F-15 control numbers. A total of 1,644 distinct NSNs appeared on those 43,722 records. This means that only 190 NSNs among the 1,834 appear *only* on D049 component-item records for the "whole" F-15 weapon system. All but 48 of the remaining 1,644 NSNs show up as parts on other reparable components and end items covered by the D049 system. (That includes other F-15 components, which accounted for 86 distinct NSNs among the 1,644.) This does not mean that those 1,596 items are *not* F-15 LRUs, but their case is not as clear. There are 48 NSNs among the 1,644 that in addition to being apparent consumable LRUs on the F-15, also appear to be consumable LRUs on other "aircraft" end items (based on the fact that "aircraft" appears in the end-item name on the D049 end-item record).

Thus, through a laborious "indenture analysis" process with the D049 data, we reduced the set of 1,834 items to a set of 238 NSNs (190 plus 48) that satisfy all our tests for being "true" consumable LRUs: the SMR and indenture codes indicate that they are consumable LRUs, *and* the D049 system shows the items on whole weapon systems only. The question for these items is whether they have even greater leverage on readiness than the 1,834 items have. They do not. Among the 238 NSNs, we matched 40 NSNs on the Langley stockage list in March 1990. Of those 40 NSNs, 19 (47.5 percent) are MIC "1" items. That figure is not statistically greater than the 44.1 percent proportion of MIC "1" items in the Langley sample of 565 NSNs out of the 1,834 items. Similarly, at Bitburg we matched 27 NSNs out of the 238 NSNs. Of those 27 items, 13 (48.1 percent) are MIC "1" items. That is not statistically greater than the 44.3 percent proportion of MIC "1" items in the Bitburg sample of 499 NSNs out of the 1,834 items.

These results imply that for the F-15 weapon system, an "O" in the third position of the SMR code, when accompanied by a "B" value in an LSAR-type indenture indicator, is sufficient to identify a set of items that have measurably greater effect on F-15 readiness than do F-15 consumable items in general.

The preceding results are important because of what they imply about how DLA should go about identifying consumable LRUs. They suggest it is *not* necessary for DLA and the Services to embark on efforts to construct and maintain elaborate indenture files for consumable weapon-system items. Given the fact that some data are missing, bad, or inconsistent, such efforts are difficult, labor-intensive, expensive, and frustrating. That was the Air Force's experience [7] in its attempts to "clean up" and use D049 records to build indenture files for its RDB project, and the Navy's experience as reported by the Center for Naval Analyses (CNA) in a study [8] of weapon-system-oriented methods for computing stockage requirements in Aviation Consolidated Allowance Lists (AVCALs) for carrier-based air wings.

Our conclusion – that consumable LRUs can be satisfactorily identified by using existing SMR maintenance codes along with available indenture codes – is based on the study of one weapon system, the F-15. What basis do we have for believing that similar methods would work for other weapon systems – in the Air Force or in other Services?

We cannot guarantee that they will. However, the codes we used, SMR codes and LSAR-type (MIL-STD-1388-2A/2B) indenture codes, are standard DoD data elements that are defined by regulation and instruction in the same way for the Air Force, the Navy, the Army, and the Marine Corps. Under those conditions, it is not unreasonable to believe that equipment specialists everywhere would interpret those regulations and instructions in the same way that F-15 equipment specialists did when they assigned SMR and indenture codes to F-15 items.

Some Examples

To make more concrete what consumable LRUs are, we close this section by listing 30 items managed by the DLA Defense General Supply Center (DGSC) that appear among the set of 1,834 NSNs identified for the F-15. Table 2-1 lists the NSNs, average requisition quantity size, unit price, name, and the DLA Weapon System

TABLE 2-1

SOME F-15 CONSUMABLE LRUs MANAGED BY THE DLA DEFENSE GENERAL SUPPLY CENTER

NSN	Price ($)	Average requisition quantity	WSIC	Name
5995010209884	1,881.05	1	F	Cable Assembly, Radio
6685008037705	1,784.78	1	F	Probe, Total Temperature
6340001924173	848.89	1	F	Control, Alarm
6220003162500	355.84	1	F	Light, Cockpit, Aircraft
6210010048758	277.66	1	F	Light, Indicator
6220005311025	249.37	2	F	Light, Cockpit, Aircraft
5995011402122	244.51	2	F	Cable Assembly, Radio
5995010555659	237.69	2	J	Cable Assembly, Special
1680001383598	234.27	3	F	Sensor Assembly
6220003028048	207.91	1	F	Light, Cockpit, Aircraft
6220003535730	187.00	1	F	Light, Cockpit, Aircraft
6220003535723	116.04	1	F	Light, Cockpit, Aircraft
6220004760487	101.63	2	F	Light, Taxiing, Aircraft
1560003072780	32.06	4	F	Cap, Filler Opening
6240005483978	24.93	31	F	Lamp, Incandescent
5355003933934	15.02	10	F	Window, Dial
6240005833334	7.36	24	F	Lamp, Incandescent
5975006025947	6.80	12	F	Convolute Reinforcement
5940010588892	4.86	55	F	Terminal, Stud
5940010656315	4.70	34	F	Terminal, Stud
5940000824642	4.08	24	F	Cover, Terminal Board
5940001434794	3.78	9	F	Terminal, Lug
5970010240090	2.05	43	F	Insulation Sleeving
6150004214197	.74	16	F	Lead, Electrical
6240008707778	.72	66	F	Lamp, Incandescent
6150010412132	.69	47	F	Lead, Electrical
6150002973926	.58	14	G	Lead, Electrical
6150002526208	.41	63	F	Lead, Electrical
6150008032853	.37	14	L	Lead, Electrical
6150008046728	.33	42	F	Lead, Electrical

Indicator Code (WSIC) for the 30 items as they appeared in SAMMS as of March 1992. The items are listed from most expensive to least expensive.

The WSICs in Table 2-1 reflect the current method DLA uses to try to characterize the various degrees of military "essentiality" that exist across items. In DLA's current system, a WSIC value of "F" represents the highest possible essentiality. Compared to a WSIC of "F," which ranks first, the WSIC values of "J," "G," and "L" rank tenth, fourth, and second, respectively. In spite of the fact that some do not carry the highest WSIC value, all the items in Table 2-1 are consumable LRUs. Lack of any one of them would be enough to render an F-15 NMCS or PMCS under normal operating conditions at F-15 bases around the world.

IDENTIFYING CONSUMABLE LRUs USED BY THE NAVY

Building on the idea that DLA can identify weapon-system consumable LRUs by using SMR data and indenture data, this section describes sources of that information in the Navy's Uniform Inventory Control Point (UICP) system. The UICP system performs the same integrated materiel management functions for Navy inventory control points (ICPs) in the Naval Supply Systems Command (NAVSUP) that SAMMS performs for DLA ICPs.[5] The NAVSUP ICPs are the Aviation Supply Office (ASO) in Philadelphia, Pennsylvania, and the Navy Ships Parts Control Center (SPCC) in Mechanicsburg, Pennsylvania. At ASO and SPCC, the particular UICP files of interest are the Program Support Interest (PSI) file and the Weapon System File (WSF). The PSI files contain SMR data, while the WSF files contain indenture data.

[5]To obtain SMR and indenture information from UICP files, DLA should coordinate through NAVSUP Headquarters. Within NAVSUP, the appropriate office is NAVSUP 0411, the Inventory Management Operations Branch, telephone (703) 607-0874.

Points of contact for obtaining information from the PSI and WSF files are: at ASO, Ms. Fran Dwyer, ASO Systems Development (ASO-042), telephone (215) 697-3740; and at SPCC, Ms. Terry Nelson, SPCC Systems Development (SPCC-042), telephone (717) 790-1776.

Besides ASO and SPCC, NAVSUP also controls the Fleet Material Support Office (FMSO) in Mechanicsburg, Pennsylvania, which is responsible for system design, programming, and documentation of the UICP system. For transferring data, FMSO is another Navy organization that can assist DLA in obtaining SMR and indenture information from the UICP system. A useful document available from FMSO is the UICP *File Data Retrieval Users Manual* (FMSO Document Number UM-PC). FMSO can provide data in hard-copy listings and on magnetic tape via batch interrogations using UICP programs in the "E48" series.

SMR Data in the Navy

At both ASO and SPCC, the purpose of the PSI file is to provide information about items (NSNs) that the Navy uses but that are managed by DLA, by another ICP, or by another Service. In particular, SMR codes for DLA-managed items are contained in the PSI records at ASO and SPCC. In the UICP system, the third position of the SMR code is UICP Data Element Number (DEN) D013A, as documented in [9]. Because the third position of the SMR code describes the lowest level of maintenance authorized to remove and replace the item on a particular system, the third position necessarily applies to an item/weapon-system combination. To identify that weapon system on an NSN record in the ASO PSI file, it is necessary to refer to the 10-character UICP Application Code (DEN D009) on the record, which identifies the "system" to which the item (NSN) in question applies.

Note that the structure in the ASO PSI file is similar to the structure of component-item records in the Air Force D049 system. In the D049 system, the third position of the SMR code describes the removability and replaceability of the component-item NSN on the end item identified by the control number at the top of the record. Thus, just as we used only those D049 end-item control numbers that applied to the *whole* F-15 weapon system (i.e., end-item control numbers for the F-15A, B, C, and D), so DLA will want to use only Navy Application Codes (DEN D009s) that apply to *whole* weapon systems [e.g., systems listed in DLA's Weapon System Support Program (WSSP) file of supported weapon systems in the Navy].

A note of caution regarding third-position SMR data in the PSI files at both ASO and SPCC: as noted in both [2] and [9], for *intra*-Navy data exchanges, the third SMR position may contain, in place of an "O," a number (a single-digit number from 2 to 7) to distinguish between the organizational-level maintenance capabilities on various classes of ships. Thus, even though the Navy is supposed to transmit an "O" when sending SMR data *outside* the Navy, DLA should be prepared to treat numbers appearing in the third SMR position on transmitted Navy records as if they were "O's."

Although [8] notes problems with third-position SMR code data in assembling AVCALs, an encouraging aspect of SMR maintenance codes in the Navy is that they are actively used to build Coordinated Shipboard Allowance Lists (COSALs), which are vital to the logistical well-being of ships at sea. Of particular interest are the

Fleet Logistics Support Improvement Program (FLSIP) and the Modified FLSIP (MOD-FLSIP) program for improving COSAL development.

Under FLSIP, the third position of the SMR code is associated with the UICP Maintenance Level Capability data element (UICP DEN D013M) "to identify those items that the *ship* (italics ours) has the capability to remove and replace" [10]. Given the importance of making that identification properly when building COSALs, it may be that third-position SMR data in the Navy are generally more reliable than they are in the Air Force, because the data are actively used to identify precisely the items of interest – namely, those items that can be removed and replaced by maintenance personnel who work directly on combat systems.

Under MOD-FLSIP, not only is removability/replaceability aboard ship considered, but also Mission Criticality Coding, which is based on Casualty Reports (CASREPs) involving the item. Items with greater relative frequency of mission-impacting CASREPs will qualify for greater range and depth in COSAL stockage than other items. Thus, consumable hardware items in COSALs that qualify for extra stockage under MOD-FLSIP are akin to the special set of items we identified in the Air Force: they are "O-level" replaceable weapon-system parts that have exhibited demonstrably greater effect on weapon-system readiness than have consumable items in general.

Indenture Data in the Navy

At both ASO and SPCC, the basic source for application and indenture information is the WSF. Navy documentation says that the WSF provides the capability "to identify each part, component, system, and subsystem to its next higher or next lower application or applications" [11]. The WSF includes information on parts in the PSI file (e.g., DLA-managed items) as well as on Navy-managed items. The WSF has a three-level structure. We are interested in the "A" level and the "C" level.

At SPCC, the "A" level in the WSF provides information about weapon systems represented by Allowance Parts List (APL) numbers. (At SPCC, APL numbers are assigned to equipments and systems so that parts lists can be associated with those equipments and systems.) At ASO, the "A" level in the WSF provides information on each aircraft/weapon system/equipment for which ASO is responsible. The system is

identified in the WSF "A" level record with a Model Item/Repairable Item Code (RIC) (UICP DEN D008).

At both SPCC and ASO, level "C" records in the WSF include the National Item Identification Numbers (NIINs) of items in the PSI (e.g., DLA-managed items) that apply to an SPCC system with an APL number or an ASO system with its own RIC. (The NIIN is the last nine digits of the NSN.) Conceptually, what DLA is interested in are DLA-managed NSNs that appear in the WSF level "C" with Next Higher Assemblies (NHAs) consisting of *whole* weapon systems (i.e., with specific D008 or D009 Application Codes for the systems on DLA's WSSP list).

In our Air Force research, LSAR-type indenture codes (along with SMR data) were enough to successfully identify F-15 consumable LRUs. Ideally, therefore, rather than attempting to identify consumable LRUs by doing "indenture analysis" with WSF records, DLA would like to obtain LSAR-type indenture codes for DLA-managed items in relation to Navy weapon systems of interest. However, in our review of [10] and [11], we were not able to identify a data element in the WSF at either ASO or SPCC that contained such an indenture code, despite the fact that ASO and SPCC both receive LSAR indenture information.

As Program Support ICPs, both SPCC and ASO receive MIL-STD-1388-2A/2B LSAR information for developing provisioning requirements for Navy weapon systems assigned to them for support. In particular, they receive LSAR "H" and "H1" records. The "H1" record [Support Items Identification (Application Related)] contains the LSAR indenture code on card H10, Block 8. (The indenture code in Air Force D049 files is defined in the same way as the indenture code that appears on an LSAR "H1" record.)

Because ASO and SPCC both receive LSAR indenture codes, they may be able to retrieve and supply the data to DLA directly (from LSAR files in their possession), for the item/weapon-system combinations of interest. (Later in this chapter we discuss an alternative way for DLA to identify consumable LRUs by directly accessing LSAR data bases.)

IDENTIFYING CONSUMABLE LRUs USED BY THE ARMY

To identify consumable LRUs used by the Army, DLA should (as in the Air Force and Navy cases) obtain third-position SMR data and LSAR-type indenture

codes for item/weapon-system combinations of interest. Weapon systems of interest are those appearing in the Army section of the DLA WSSP list of supported weapon systems.

The Provisioning Master Record (PMR) file in the Army's Commodity Command Standard System (CCSS) contains both SMR codes and LSAR indenture data for item/weapon-system combinations. The CCSS basically performs the same integrated materiel management functions for Army ICPs [i.e., Major Subordinate Commands (MSCs)] in the Army Materiel Command (AMC) that SAMMS performs for DLA ICPs.[6]

As described in [12], the PMR file is the central repository in the Army for data used in the provisioning cycle of an Army end item. The PMR provides the capability to identify all the parts used within an end item. In PMR records, weapon systems are identified by a Provisioning Contract Control Number (PCCN). For identifying consumable LRUs, the PCCNs of interest to DLA will be those for Army weapon systems that DLA supports in its WSSP.

Items on PMR records are identified by Provisioning List Item Sequence Numbers (PLISNs). A different CCSS file, the Provisioning Cross-Reference (PXR) file (also described in [12]), links NSNs and manufacturer part numbers to PLISN-PCCN combinations in the PMR file.

For item/weapon-system combinations (i.e., PLISN-PCCN combinations), PMR records provide both SMR data and indenture data. The one-character LSAR Indenture Code (INDCOD) for a PLISN-PCCN combination appears in sector 00, segment 000 of a PMR record. Note that if the INDCOD has a value of "B," the item on the record is a first-indenture item on the weapon system associated with the PCCN.

The third and fourth positions of the SMR code appear as their own, two-character PMR data element called the Maintenance Level (MAINT-LVL), Code which appears in sector 01, segment 000 of a PMR record. Another data element of

[6]A point of contact at AMC headquarters for the CCSS PMR file is Mr. Burton L. Nichol, AMCSM-MMS, telephone (703) 274-9841. The information presented here about the PMR file is contained in [12], published by the AMC Systems Integration and Management Activity (SIMA) in St. Louis, Missouri. The Information Technology Branch in the Technical Resources Division of SIMA is responsible for the PMR file.

interest in sector 01, segment 000 is a single-character (Yes/No) indicator of whether or not the item is an LRU on the end item. In [12], an LRU is described as

> *An essential support item which is removed and replaced at field level to restore the end item to operationally ready condition. Conversely, a non-LRU is a part, component, or assembly used in the repair of an LRU when the LRU has failed and has been removed from the end item for repair.*

Any DLA-managed items coded "Y" in this data element are certainly strong candidates to be consumable LRUs in the Army. It may be useful, therefore, for DLA to use this data element in conjunction with (or possibly instead of) the combination of indenture code and third-position SMR maintenance code.

Identification data (including the maintenance-level code and the LRU code) are supposed to appear in all PMR records for a PLISN-PCCN combination in which the INDCOD data element is not blank. That means DLA should be interested in PLISN-PCCN combinations involving DLA-managed items in which the item is coded as being first-indenture on the weapon system (INDCOD equals "B"); removable by organizational-level maintenance personnel (MAINT-LVL equals "O"); and an LRU (LRU equals "Y"). Given the traditional interpretation of LRUs as being reparable-type items only, it is possible that the LRU field may be blank or missing for DLA-managed consumables in PMR records. In that case, DLA should rely on the SMR code and indenture code to identify consumable LRUs used by the Army.

A possible alternative source for Army PMR data is the Army's Operating and Support Management Information System (OSMIS), operated by the Army Cost and Economic Analysis Center in Falls Church, Virginia. Used by the Army for setting costs and determining materiel management budget requirements by system, OSMIS captures data from the CCSS PMR file as one of its data sources.[7]

AN ALTERNATIVE WAY TO IDENTIFY CONSUMABLE LRUs

Both SMR codes and indenture codes for item/weapon-system combinations are included as data elements in the "H1" record portion of an LSAR data base. Standard LSAR data bases exist for most weapon systems in the DoD inventory. For older

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[7]The Army receives contractor support for OSMIS applications from CALIBRE Systems, Inc., in Falls Church, Virginia. CALIBRE briefed DLA in 1991 on the possibility of using OSMIS to assist in budget projections for Army materiel. Obtaining SMR and indenture data from PMR records is another possible application for OSMIS at DLA. A point of contact at CALIBRE is Mr. Fred Lokay, Director of Logistics Programs, telephone (703) 845-1000.

systems, the LSAR data will be in the MIL-STD-1388-2A format. For newer systems (i.e., systems in acquisition since 1991), the LSAR data will be in the MIL-STD-1388-2B format. In both formats, SMR codes and indenture codes are standard data elements. As an alternative way to obtain SMR and indenture information for item/weapon-system combinations, therefore, DLA may wish to directly access LSAR data bases – rather than working with individual Service data systems, as discussed in the preceding sections.

A system has already been developed to provide DLA with direct query capabilities into MIL-STD-1388-2A LSAR data bases. Working with the Defense Advanced Research Projects Agency (DARPA) and the University of Southern California's Information Sciences Institute, DLA has developed the Data Review, Analysis, and Monitoring Aid (DRAMA) system to provide item managers direct and flexible access to LSAR files.

A new application for DRAMA would be to identify weapon-system consumable LRUs by accessing third-position SMR data and indenture data in LSAR files for the weapon systems DLA supports in its WSSP.

CONSUMABLE LRUs AND THE WSSP

So far in the discussion of consumable LRUs, we have deliberately *not* restricted our attention solely to items in the DLA Weapon System Support Program (WSSP). Instead, we have proposed extracting SMR and indenture data from Service data systems for *all* DLA-managed consumables, whether or not they are in the WSSP.

Some DLA-managed items applying to weapon systems are not yet in the WSSP. Either the Services have not requested that the item be included, or application data are incorrect or missing, or there are various disconnects between application files in the Services and the WSSP file at DLA. Below, we present evidence of the problem as it applies to consumable LRUs. The point is that by considering *all* consumables when searching for consumable LRUs, DLA will also be taking steps to reconcile the WSSP file with Service files for weapon-system consumables. In particular, it is important that all consumable LRUs be registered in the WSSP.

Among the roughly 340,000 NSNs in the DLA WSSP in March 1990 (of which 21,793 had application to the F-15), we were able to match NSNs for 1,021 (55.7 percent) of the 1,834 DLA-managed F-15 consumable LRUs that we found by using March 1989 Air Force D049 records. This means that 813 DLA-managed consumable hardware parts applying *directly* to the F-15 as consumable LRUs were not yet in the DLA WSSP as of March 1990.

Among the 1,021 consumable LRU F-15 items in the WSSP, most (but not all) do show application to the F-15 in the WSSP records. In the WSSP records, 965 NSNs out of the 1,021 show the F-15 as an applicable weapon system; 56 NSNs do not.

Consumable LRUs and Item Essentiality

For items in the WSSP, WSICs are supposed to capture their "essentiality" and thereby help item managers differentiate for management purposes. Are WSICs useful for identifying consumable LRUs? The evidence is that, by themselves, they are not. Among the 1,021 F-15 consumable LRUs in the March 1990 WSSP (any one of which can render an F-15 PMCS or NMCS), 549 NSNs (53.7 percent) had the highest possible WSIC, while the remaining 46.3 percent did not. The latter figure *includes* 139 NSNs (13.6 percent) with the *lowest* possible WSIC (indicating that lack of those items would have *no* effect on the weapon system).[8] This is not to say that WSICs cannot play a useful role, but it does suggest that as tools for supporting readiness they are not very helpful.

Consumable LRUs Are Not Numerous

In March 1990, 25.3 percent of all the items in the demand-based portion of the WSSP had the highest possible WSIC. That makes the usefulness of WSICs as a resource allocation tool questionable. The more items that are "most important," the harder it is to justify reducing safety levels when money has to be saved.

The situation is different for consumable LRUs. Suppose we add to the 1,021 F-15 consumable LRU NSNs that were in the WSSP in March 1990 the 813 F-15 NSNs that were not. Further, suppose that the 56 F-15 NSNs that were in the WSSP but did not show an F-15 application in the WSSP file did, in fact, show such

[8]WSICs are assigned on the basis of a combination of the criticality of the weapon system and the essentiality of the item to the system. A WSIC of "P" corresponds to "most-critical" weapon systems but indicates that the item has no effect on the weapon system. A total of 139 F-15 consumable LRU NSNs had a WSIC of "P."

an application. That would place a total of 22,662 F-15 items in the WSSP (21,793 NSNs already registered, plus 813 new NSNs, plus 56 more identified to the F-15). The set of 1,834 F-15 items that we identified as "most important" (because they are consumable LRUs) would represent less than 10 percent of the total number of demand-based F-15 items in the WSSP.

Of course the ratio of consumable LRUs to total consumables will vary from weapon system to weapon system. Nevertheless, the F-15 results suggest that classifying only consumable LRUs as the "most important" items in the WSSP would substantially reduce the total number of "most important" items in the program. That offers opportunities for cost savings that do not currently exist.

[*Note:* The fact that non-LRU consumable items would not qualify as "most important" *does not mean* that such items are not important. Non-LRU items would still require appropriate safety levels to protect against variations in leadtime demand. The point is only that, other things being equal, appropriate "readiness-protecting" safety levels for non-LRU consumables do not need to be set at the same levels as those for LRU consumables.]

RECOMMENDATIONS

The findings in this chapter suggest that identification and proper classification of consumable LRUs at DLA's four hardware centers offer DLA opportunities to save money on safety levels while maintaining and improving support to weapon-system readiness. To make that happen, LMI recommends that DLA take the following steps.

Recommendation 1

Identify and place more emphasis on consumable LRUs. To identify consumable LRUs, DLA should plan to use third-position SMR maintenance codes and LSAR-type indenture codes for item/weapon-system combinations of interest.

The weapon systems of interest are weapon systems supported by the WSSP. As of January 1989, the WSSP was supporting 1,109 distinct systems: 452 in the Army, 203 in the Navy, 206 in the Air Force, and 248 in the Marine Corps. In the search for consumable LRUs, the items of interest should include *all* DLA-managed hardware items – i.e., all demand-based (DLA Item Category Code 1) items and all non-

demand-based (numeric stockage objective and insurance) items, whether or not they are registered in the DLA WSSP. Considering all DLA-managed items is important to capture as many consumable LRUs as possible and to help reconcile differences between the DLA WSSP file and Service files concerning weapon-system consumables. Considering all DLA-managed items as candidates will make the job of finding consumable LRUs easier, because identification of DLA as the wholesale source of supply is one reasonably sure piece of information carried in Service data systems.

The Defense Logistics Agency can obtain the required SMR and indenture information by extracting data from Service files described in this report or by accessing LSAR data bases for the weapon systems of interest.

Recommendation 2

As SMR and indenture data are obtained, register consumable LRU items in the WSSP (if they are not already registered). Establish a new item classification scheme in the WSSP file to complement existing "item essentiality" codings by identifying consumable LRUs with their own new (or modified) data element. Items used on more than one weapon system should receive the consumable LRU classification if they are a consumable LRU in any of their applications.

Recommendation 3

Insert an "LRU factor" into the formula used to compute wholesale safety levels. The LRU factor should be a multiplicative adjustment factor applied to the item essentiality factor already in the formula (see Equation 2.1 below). For consumable LRUs, the LRU factor should be 1.0; for non-LRUs, the factor should be slightly less than 1.0.

Equation 2-1 is the SAMMS formula for computing an item's safety level. The safety level factor k_i is multiplied by the standard deviation in leadtime demand to determine the item's safety level. Equation 2-2 is identical, except that the "LRU factor" has been inserted. If the LRU factors suggested (1.0 for consumable LRUs and less than 1.0 for non-LRUs) are used, the safety level for consumable LRUs would not change, while the safety level for non-LRU consumables would get smaller. For

example, if the LRU factor for non-LRUs were set at 0.9, the safety level for a non-LRU item with a current safety level factor of k_i would decrease by $(7.45/k_i)$ percent.

$$k_i = -0.7071\, ln \left[\frac{2.56\, S_i\, Q_i\, c_i\, B}{Z_i\, madlt_i \left(\sum_j c_j\, madlt_j \right) \left(1 - exp\left(\frac{-1.13 Q_i}{madlt_i} \right) \right)} \right] \quad \text{[Eq. 2-1] (Ref. [13])}$$

Alternative safety level formula with an LRU factor:

$$k_i = -0.7071\, ln \left[\frac{2.56\, S_i\, Q_i\, c_i\, B}{(LRU\, factor)\, Z_i\, madlt_i \left(\sum_j c_j\, madlt_j \right) \left(1 - exp\left(\frac{-1.13 Q_i}{madlt_i} \right) \right)} \right]. \quad \text{[Eq. 2-2]}$$

k_i = safety level factor for item i

S_i = average requisition size for item i

Q_i = order quantity for item i

c_i = unit price (acquisition price paid to a commercial supplier) for item i

B = system backorder target [expressed in terms of average number of outstanding line (requisition) backorders] for an entire collection of items

Z_i = essentiality factor for item i (DLA uses values from 1 to 9)

$madlt_i$ = mean absolute deviation in leadtime demand for item i.

Use of the "LRU factor" approach would protect DLA items that have the greatest leverage on readiness (consumable LRUs) while reducing safety level requirements for non-LRU consumables. Because consumable LRUs are not numerous, replenishment spending would go down for large numbers of items at DLA's four hardware centers.

Recommendation 4

Take the necessary steps within the JLSC framework of "business process improvements" to ensure that DLA can obtain, store, and use both third-position SMR data and LSAR-type indenture data for item/weapon-system combinations of interest.

GENERAL COMMENTS

Recommendation 1, to identify and focus on consumable LRUs, is based on the findings that (1) consumable LRUs have significantly greater influence on weapon-system readiness rates than do other DLA-managed items and (2) consumable LRUs can be successfully identified using a *combination* of standard data elements (namely SMR codes and LSAR-type indenture codes) already present in existing Army, Navy, and Air Force data systems.

Recommendation 2, to register identified consumable LRUs in the WSSP, is based on the idea that all weapon-system items managed by DLA should be registered in the WSSP, *particularly* if they are consumable LRUs. As noted earlier, that is not currently the case. [A total of 813 NSNs (44.3 percent) of the 1,834 consumable LRUs on the F-15 were not registered in the WSSP as of March 1990.]

The Defense Logistics Agency's current procedure is to place an item in the WSSP only if formally requested to do so by one of the Services. Acting on Recommendation 2 entails a policy decision by DLA to update the WSSP file on its own, using SMR and indenture code data it collects itself. Doing that would be consistent with the emerging CIM/JLSC policy concerning the treatment of weapon-system items. It is also consistent with Recommendation 7 (see Chapter 5); namely, that weapon-system items should be one of the defining groups DLA uses when computing *system* safety levels.

The LRU factors suggested in Recommendation 3 [1.0 for LRUs, slightly less than 1.0 (e.g., 0.9) for non-LRUs] preserve safety levels for consumable LRUs and reduce them slightly for non-LRUs. We estimate that consumable LRUs constitute less than 10 percent of the items in the WSSP. Use of the suggested factors, therefore, gives DLA a way to maintain support for items that have the greatest

leverage on readiness (consumable LRUs) while prudently reducing replenishment purchases for large numbers of non-LRU items.

Recommendation 4 is motivated by the fact that identification of consumable LRUs is a necessary prerequisite for successful implementation of secondary item weapon-system management at DLA. The JLSC has set itself the task of developing a single, standard, weapon-system-oriented requirements system for secondary items that apply to weapon systems. For DLA-managed items, the item records in the new DLA system must include third-position SMR maintenance data and LSAR-type indenture data for item/weapon-system combinations. DLA needs to ensure that it will have access to SMR codes and indenture data in order to identify consumable LRUs.

Neither SAMMS nor the WSSP file at DLA currently receive or have the capability to store third-position SMR maintenance codes or LSAR-type indenture codes for item/weapon-system combinations. Adding this new information to DLA's current system would be a way to achieve improvements sooner, rather than waiting for JLSC systems to come on line. The job of changing the current system would have two parts: getting the data from the Services and using the data. Getting the data would require establishing procedures for receiving Service data (from Service files that have varying structures). Using the data would mean processing the data, loading them into SAMMS and the WSSP file, and periodically updating them. It is not clear that these things can be done under current funding procedures for "maintenance and operation" of existing systems. Thus, it is important for DLA to take steps to ensure that in future CIM/JLSC systems, the capability will exist both to obtain and to maintain third-position SMR data and LSAR-type indenture data in the DLA system.

Acting on the recommendations for consumable LRUs does not guarantee that DLA will pick up every consumable LRU in its inventory. Missing, incorrect, or non-available data, however, make construction of "perfect" consumable LRU files virtually impossible, no matter what method is tried.

Finally, placing emphasis on consumable LRUs does not relieve DLA of the responsibility to also seek better ways to support intermediate- and depot-level repair activities. (Recommendation 5 in the next chapter offers one way to do that.) In any case, by adjusting safety levels through the use of the LRU factors suggested, DLA can focus on consumable LRUs without reducing repair-part safety levels "too much."

CHAPTER 3

TRACKING READINESS EFFECTS AND DEMAND AT THE RETAIL LEVEL

OVERVIEW

As a wholesale supply organization, DLA does not deal directly with fielded weapon systems – retail supply organizations controlled by the Services do. This means that DLA's influence on weapon-system readiness is, to a very large extent, limited and tempered by retail stockage policy and practice. Therefore, even if it places more emphasis on identifying and supporting consumable LRUs, DLA must also pay attention to what retail supply points are doing, if it is to control its influence on readiness.

In the first part of this chapter, we look at some interesting retail supply data that shed more light on the connection between DLA operations and weapon-system readiness. Following a review of those data, we recommend some procedural steps DLA can take to proactively identify and support items that, because of retail supply practice, are especially likely to be the ones that influence weapon-system readiness in the field.

In the latter part of the chapter, we look at the Navy's practice of referring retail due-outs to DLA and at what DLA can learn about readiness effects in the Navy as a result. In particular, we show that the Navy information supports the view that DLA supply performance affects the readiness of aircraft in the Navy in proportion to the way it affects the readiness of aircraft in the Air Force.

The chapter ends with some brief comments on the prospects for "multi-echelon" supply modeling at DLA and the role that retail data play in such models. Multi-echelon supply requirements models are being promoted as part of the DoD CIM effort to develop a standard DoD logistics system for the future.

HIGH-PRIORITY RETAIL DUE-OUTS AND DLA

Air Force Practice

Even though DLA is not on the front line with combat units, sometimes retail organizations take actions that make DLA, whether it likes it or not, the supply point of first and last resort. If a retail supply point does not stock a particular consumable item, for example, and the item is requested, the retail due-out will quickly become a wholesale requisition that DLA must try to fill. If a weapon system is waiting, it will be waiting directly on DLA. Data from the Air Force, first presented in [1] and reiterated in Table 3-1, show that a large proportion of the high-priority requisitions DLA receives from the Air Force fall into this category.

Table 3-1 reproduces a MICAP Cause Code Analysis report for MICAP incidents worldwide in the Air Force in March 1989. The term "MICAP" is a shortened form of "mission capable" and refers to the occurrence of a mission-capability-affecting demand on supply. The table is drawn from a centralized report that, each month, summarizes the information in the base-level "M32" supply reports that are produced every month at Air Force bases worldwide. The centralized report is assembled by the Standard Systems Center (SSC) at Gunter AFB in Montgomery, Alabama. The SSC is the programming center for the Air Force Standard Base Supply System (SBSS), the system that controls retail stockage in the Air Force. Each month, the SSC produces an Air Force-wide roll-up of the information appearing in the base-level "M32" management reports that supply officers at the bases use to manage their local systems.

Consumable items are referred to as EOQ items in Table 3-1 because they tend to be managed using inventory control systems that employ "reorder points" and "economic order quantities." Repair cycle items are either depot-level-reparable items or intermediate-level-reparable items.

A MICAP incident at a base occurs when base supply is unable to fill a demand related to an NMCS or PMCS weapon system and a UMMIPS high-priority requisition (priority designator 01 – 08) has gone off the base to obtain the item from a wholesale supply point. The report in Table 3-1 is typical, both in the number of monthly MICAP incidents worldwide in the Air Force and in the relative frequencies of the different causes that are listed.

TABLE 3-1

WORLDWIDE AIR FORCE MICAPs – MARCH 1989

Cause code	Rep. cycle XD[a]		Rep. cycle XF[a]		EOQ items		Eqmt. items		Total	
	Number	%	Number	%	Number	%	Number	%	Number	%
A – NO STK LVL-NO DEMAND	3016	14	1177	39	11177	50	17	100	15387	33
B – NO STK LVL-W/DEMANDS	1833	8	425	14	2553	11	0	0	4811	10
C – IM/SM PROHIBITS LVL	1	0	2	0	12	0	0	0	15	0
D – BASE DECISION-NO LVL	0	0	1	0	135	0	0	0	136	0
F – FULL STOCK-0 BALANCE	68	0	22	0	109	0	0	0	199	0
G – FULL STOCK-ASSETS AWP	701	3	48	1	15	0	0	0	764	1
H – <FULL STK-RQN > STD	11456	55	642	21	3870	17	0	0	15968	35
J – <FULL STK-RQN < STD	784	3	263	8	2601	11	0	0	3648	8
K – < FULL STK-NO DUE IN	1006	4	231	7	1618	7	0	0	2855	6
P – COMMAND UNIQUE	0	0	0	0	0	0	0	0	0	0
R – FULL STK-INACCESSIBLE	1054	5	111	3	15	0	0	0	1180	2
S – <FULL STK (G/H)	341	1	9	0	5	0	0	0	355	0
T – <FULL STK (G/J)	20	0	5	0	0	0	0	0	25	0
X – <FULL STK (G/K)	63	0	2	0	0	0	0	0	65	0
Z – INITIAL SHORTAGE	126	0	39	1	18	0	0	0	183	0
Total	20469		2977		22128		17		45591	

Cause code	5 ALCs[b]		DLA		Other		Total	
	Number	%	Number	%	Number	%	Number	%
A – NO STK LVL-NO DEMAND	5350	22	5611	57	4426	38	15387	33
B – NO STK LVL-W/DEMANDS	2238	9	1159	11	1414	12	4811	10
C – IM/SM PROHIBITS LVL	1	0	0	0	14	0	15	0
D – BASE DECISION-NO LVL	15	0	13	0	108	0	136	0
F – FULL STOCK-0 BALANCE	103	0	52	0	44	0	199	0
G – FULL STOCK-ASSETS AWP	606	2	7	0	151	1	764	1
H – <FULL STK-RQN > STD	11911	49	1160	11	2897	25	15968	35
J – <FULL STK-RQN < STD	1436	6	1041	10	1171	10	3648	8
K – < FULL STK-NO DUE IN	1335	5	732	7	788	6	2855	6
P – COMMAND UNIQUE	0	0	0	0	0	0	0	0
R – FULL STK-INACCESSIBLE	920	4	20	0	240	2	1180	2
S – <FULL STK (G/H)	306	1	0	0	49	0	355	0
T – <FULL STK (G/J)	18	0	2	0	5	0	25	0
X – <FULL STK (G/K)	52	0	0	0	13	0	65	0
Z – INITIAL SHORTAGE	139	0	14	0	30	0	183	0
Total	24430		9811		11350		45591	

[a] The terms "XD" and "XF" are Expendability, Recoverability, Repairability Category (ERRC) designators. "XD" items are subject to depot-level repair. "XF" items are subject to intermediate-level repair.

[b] Five Air Logistics Centers (combined): Oklahoma City ALC, Warner-Robins ALC, San Antonio ALC, Sacramento ALC, and Ogden ALC.

The gist of LMI's 1990 discussion about the table (see the final appendix in [1]) is that most MICAP incidents involve situations over which DLA has no control. A careful examination of the cause codes that consistently account for more than 90 percent of consumable-item MICAPs (namely, cause codes A, B, H, J, and K) shows that only cause code H reflects a problem at the wholesale level.[1] Every other cause code reflects retail stockage policy or practice at the bases, over which DLA has no control.

The particular point of interest here is the percentage of MICAP requisitions for consumable items that result because the base does not stock the item. Cause codes A and B say the reason why the MICAP incident occurred is that the base did not stock the item – either because there had been no previous demand or because there had not been enough previous demand to satisfy the SBSS "range" rules to qualify for stockage.

Table 3-1 shows that in March 1989, nonstockage at the retail level accounted for more than 60 percent of the MICAP requisitions for consumable (EOQ) items generated that month. That percentage is typical of the Air Force's experience from month to month.[2]

Navy Practice

Evidence from the Navy suggests that the same thing occurs at naval air stations. In 1989, the Fleet Material Support Office (FMSO) and NAVSUP were

[1]Cause code A means that the base does not stock the item because there has been no previous demand. Cause code B means that there has been some previous demand but not enough to justify stockage under the base stockage policy. Cause code J means that although the item is stocked, there are no assets on hand to issue and therefore a replenishment requisition has been sent; however, the full UMMIPS time standard for satisfying the requisition has not yet elapsed. Cause code K means that although the item is stocked, there are no assets on hand to issue, and a replenishment requisition has not been sent (there is no due-in). Cause code H means that the item is stocked but replenishment from wholesale has exceeded the UMMIPS time standard, and a MICAP incident has occurred during the extra waiting time. Among the various causes, only cause code H reflects a wholesale delay problem. The others all reflect the results of *retail* stockage policy or practice.

[2]In March 1989, EOQ items included both DLA-managed consumables and Air Force Logistics Command (AFLC)-managed consumables. The latter were managed in the Systems Support Division (SSD) of the Air Force stock fund. That is why the Table 3-1 counts in the lower column for DLA items do not match the counts in the upper column for EOQ items. The Air Force's SSD consumables are being transferred to DLA for management under the DoD Consumable Item Transfer Program. The difference between the counts in the upper EOQ column and the lower DLA column are interesting, therefore, because they give an indication of the "MICAP-causing" potential of the Air Force consumables being transferred to DLA.

funding retail stockage levels for "9 Cog" materiel to support a 76 percent Point-of-Entry (POE) supply effectiveness rate (i.e., funding both range and depth of stockage so that 76 percent of retail issue requests could be expected to be filled). (Cognizance code "9" materiel in the Navy supply system is materiel managed at the wholesale level by DLA or by some other non-Navy organization.)

In a telephone interview in the spring of 1989, the Supply Officer at Cecil Field, a large naval air station in Jacksonville, Florida, supporting roughly 300 aircraft (about 160 F-18s, 70 S-3s, and 60 A-7s), stated that retail supply at Cecil was, in fact, achieving a 76 percent POE effectiveness for 9 Cog materiel. His conclusion was that most outstanding high-priority requisitions to DLA to fill NMCS/PMCS-type due-outs to customers existed because the items were simply not on the retail stockage list at Cecil. The due-outs existed not because DLA wasn't replenishing Cecil's stocked items as required but because, for retail funding reasons, *some items simply* were not being stocked. For those items, DLA was the supplier of first resort.

Army Practice

Retail levels in the Army for combat units are specified in Prescribed Load Lists (PLLs) at the unit level and Authorized Stockage Lists (ASLs) at the direct support level. Army supply regulations [14] specify that to add an item to a PLL requires at least three demands in the most recent 180-day period. To keep an item on a PLL requires at least one demand in the past 180 days. To add an item to an ASL requires at least nine demands in the previous 360 days, while keeping an item on an ASL requires at least three demands in the last 360 days. A typical PLL stocks a range of roughly 300 different items (NSNs). An ASL stocks roughly 5,000 different items.

The limited range of stock in a PLL increases the likelihood that a high-priority demand from an end user will be for an item the PLL does not stock. However, because PLLs normally turn to ASLs as their supplier of first resort, we are more interested in the demand experience of ASLs. When high-priority requisitions go up to wholesale from ASLs, how often is it the case that the item is not stocked in the ASL?

The Army does not have a report similar to the Air Force's worldwide MICAP Cause Code Analysis report, so it is harder to answer this question for the Army than it is for the Air Force. It is possible (if not straightforward) that an answer could be extracted using information in the Central Demand Data Base (CDDB) and the

Logistics Intelligence File (LIF) maintained by the AMC Logistics Control Activity (LCA) in San Francisco, California.[3] As an alternative, we checked with the Army Materiel Systems Analysis Activity (AMSAA) in Aberdeen, Maryland, to see whether an AMSAA team working on a demonstration of sparing-to-availability in the Army had anecdotal information that could help answer the question.

In the course of the sparing-to-availability demonstration, AMSAA has collected the following information about recent experience in the Army's Fifth Infantry Division: For "essential" NSNs (i.e., secondary items with a direct weapon-support, legal, or safety function), 26 percent of demands on the ASLs are for nonstocked items. Of the remaining 74 percent of demands, for items that are stocked, the ASLs are accommodating 83 percent, with the other 17 percent generating requisitions to the wholesale level. Thus, 12.6 percent (0.17 times 0.74 equals 0.126) of wholesale requisitions are for ASL-stocked items, whereas 26 percent, more than twice as many, are for nonstocked items in the ASL.

This does not prove that nonstockage is usually the cause of high-priority requisitions from ASLs to DLA, but it does suggest that nonstockage is more often than otherwise the reason why wholesale requisitions go forward.

RECOMMENDATION

On the basis of retail-level supply information from the Air Force, Navy, and Army, it appears that many (if not most) of the high-priority requisitions DLA receives for hardware items are generated because the item is not stocked at the given retail supply point. By tracking and providing retail stockage data, as suggested in the next recommendation, DLA can better support readiness across the board for all hardware items without spending any more on wholesale stockage.

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[3]When user requests cannot be filled and requisitions go up to wholesale, Army systems [the Direct Support Unit Standard Supply System (DS4) and the Standard Army Intermediate Level Supply (SAILS)] system carry the original document identifier number forward. That would make it possible to connect demands in the CDDB with high-priority requisitions identified in the LIF that have gone up to DLA from an ASL. To determine whether the item was stocked or not in the ASL, it would be necessary for the LCA to review the item's demand history at that ASL to determine whether it satisfied the ASL range rules and was therefore likely to be a stocked item.

Recommendation 5

For all its hardware items, DLA should have (or be able to generate) an automated file for each NSN listing the retail supply points in the Army, Navy, and Air Force that do and do not stock the given NSN. Retail supply points can be identified by DoD Activity Address Code (DoDAAC). Then, when it receives a high-priority requisition it cannot fill, DLA should automatically send the requesting site a list of retail sites that do stock the item. "High-priority" requisitions are those in issue priority group (IPG) I or II (i.e., priority designator 01 – 08) with an NMCS/PMCS code or a Joint Chiefs of Staff (JCS) project code.

GENERAL COMMENTS

Recommendation 5 is, in effect, an extension of the long-standing DLA practice of checking the demand histories of backordered items to identify recent customers that may be able to help satisfy a high-priority demand. It is also consistent with DLA's participation in the DoD Total Asset Visibility (TAV) initiative as described in [15].

The TAV initiative calls for DLA to be tied into the Service systems that already exist or are under development to support *intra*-Service lateral resupply. Described in [15], those systems are: the Objective Supply Capability (OSC) system in the Army; the Material Visibility (MVIS) system for Navy shipyards; the Naval Aviation Depot Visibility (NADEPVIS) system for naval aviation depots; the Virtual Master Stock Item Record (VMSIR) system in the Navy for non-Navy-managed items; the Supported Activities Supply System (SASSY) in the Marine Corps; and the MICAP Asset Sourcing System (MASS) in the Air Force. Interfaces between DLA and Service retail systems were successfully used during Operations Desert Storm and Desert Shield (ODS) to satisfy large numbers of ODS-related requisitions through lateral resupply when DLA was unable to fill the requisitions from wholesale stocks [15], [16].

The Service systems above are designed to provide visibility within the owning Service only; they do not cross Service lines. As the manager of many common items used across the Services, DLA could provide useful *inter*-Service visibility by maintaining and providing the information outlined in Recommendation 5.

Note that Recommendation 5 is silent on whether DLA should be empowered to actually direct or control lateral redistribution of physical assets. DLA's role in that regard will be decided over the longer term within the TAV program. Recommendation 5 says merely that DLA should provide *information* about other locations where assets may be available. The Defense Program for the Redistribution of Assets (DEPRA) is a centralized system for screening requisitions against retail assets. The DEPRA system, however, is aimed more at promoting efficient use (and preventing premature disposal) of items in long supply than it is at supporting readiness. The DEPRA system considers only items above the requisitioning objective[4] at participating sites and then only for IPG II and III requisitions. The highest priority requisitions (IPG I requisitions, priority designators 01 – 03) are not screened through DEPRA.

Recommendation 5 is aimed at giving DLA a way to assist retail activities when DLA is unable to fill a requisition that is downing a weapon system or other important piece of equipment. The goal is to shorten the time it takes to fill high-priority, readiness-affecting due-outs whenever and wherever they occur. Remember, the recommendation says only that DLA should pass information about stockage locations. Those locations may or may not have issuable assets available for lateral redistribution. As long as DLA's role is simply one of providing information, the Services cannot complain about DLA control. In any case, the Services should continue to expect DLA to work on filling the original requisition. If a lateral resupply action does happen to solve a high-priority backorder problem (and it is not a DEPRA redistribution of a long-supply asset), DLA will still have responsibility for replenishing the retail site that carried the item and was willing to part with it.

USING RETAIL DUE-OUTS TO ESTIMATE READINESS EFFECTS ON NAVAL AIR

In our earlier research [1], we used retail supply performance data from the Air Force (the "M32" worldwide summaries) to help derive a rule of thumb describing the increase in NMCS/PMCS aircraft that would accompany an increase in wholesale backorders at DLA. In particular, the Air Force data allowed us to estimate the number of high-priority (UMMIPS priority designator 01 – 08) due-outs outstanding at any given time for DLA-managed items at typical Air Force bases. That number

[4]The requisitioning objective for a secondary item at a retail site represents the maximum quantity of stock authorized to be on hand or on order at any given time, after subtracting any outstanding due-outs.

was central to the estimation of NMCS/PMCS aircraft effects. To estimate aircraft effects in the Navy, similar estimates of the average number of outstanding high-priority due-outs at Navy installations are required.

Unfortunately, as noted earlier, neither the Army nor the Navy has a system like the Air Force's "M32" system for summarizing retail supply activity. In the Navy's case, however, another method does exist for measuring the average number of outstanding high-priority due-outs for DLA items at Navy installations. The only requirement is that the installation have a DoDAAC.

The method relies on the fact that the Navy routinely refers unsatisfied retail issue requests for DLA items back up to DLA in the form of "A4" requisitions. All requisitions carry a Document Identifier Code (DIC) identifying whether the requisition is a replenishment requisition (A0), a passing order (A3), a referral (A4), or an issue (D7). The Navy refers requisitions whether or not the item is stocked at the retail site and (if the item is a stocked item) whether or not an A0 replenishment requisition has already been submitted.

This practice in the Navy is documented in a 1988 DLA study [17] that examined why DLA supply availability rates for the Navy were consistently below those for the Army and Air Force. At the time of the study, 51 percent of *all* Navy requisitions to DLA were A4 referrals.

Because of the size of its aircraft population, we chose Cecil Field Naval Air Station for an experiment. Cecil has the advantage of having 1989 data that can be used to check results.

Using requisition histories for the Defense Industrial Supply Center (DISC) for the second quarter of FY90 [in a GOR.MAR.RQN902.I file from the DLA Integrated Data Bank (DIDB)], we went about estimating the average number of outstanding due-outs at Cecil for DISC items during that period, stratified by UMMIPS priority group. We chose DISC because DISC receives a significantly larger share of the demand for WSSP items than any of the other three DLA hardware centers [1].

We used the following logic: Every due-out for a DISC item at Cecil sometime during the second quarter of FY90 corresponds to a record in the history file for an A4 requisition that DISC received from Cecil. Either the requisition would be open at the end of the quarter or DISC would have closed it sometime during the quarter.

The requisition history file contained 4,200 records reflecting A4 requisitions received by DISC from Cecil that were either closed during the quarter or were still open at the end of the quarter. Using the document birth date at Cecil (a data element on the record) and the depot ship date (we used the end of the quarter if the requisition was still open), plus the appropriate UMMIPS ship time, we constructed "time lines" for the 4,200 records. The time line for each extends from the document birth date (the beginning of the quarter if the requisition arrived at Cecil before the start of the quarter) to the estimated time when Cecil would have received the item from DISC, or (if the requisition was not closed) the end of the quarter. By taking "slices" across those time lines at randomly chosen dates within the quarter, we were able to count the number of outstanding due-outs for DISC items that existed at Cecil on those dates. Table 3-2 shows the results.

TABLE 3-2

ESTIMATING OUTSTANDING DUE-OUTS AT CECIL FIELD FOR DISC ITEMS
(Second quarter – FY90)

Julian date	Outstanding due-out count (total)	Count by UMMIPS priority group		
		I	II	III
90005	870	132	465	273
90020	1,679	244	1,020	415
90041	1,702	221	1,036	445
90047	1,599	262	874	463
90070	1,631	424	757	450
90085	1,730	492	774	464
		Avg = 295	Avg = 821	Avg = 418

As indicated in Table 3-2, our estimate of the average number of IPG I (UMMIPS priority designator 01 – 03) retail due-outs for DISC items in place at Cecil Field at any given time is 295 due-outs. For IPG II (UMMIPS priority designator 04 – 08), the average is 821 due-outs. [*Note:* we used requisition *quantities* in our analysis, so these are counts of *unit* due-outs at Cecil for individual items, not counts of backordered retail issue requests. (For example, a single back-ordered issue request for two units would count as *two* unit due-outs.)]

The term "NORS" stands for "Not Operationally Ready – Supply" and means the same thing as "NMCS." On 1 May 1989, a little less than a year before the quarter under study, we had asked the Supply Officer at Cecil Field how many NORS "holes" on aircraft existed that day for DLA-managed items. His estimate was that out of 215 priority designator 01 NORS aircraft holes in his log, about 25 percent (about 54 holes) were for DLA-managed items. That number is not inconsistent with the estimate in Table 3-2 that the number of priority designator 01, 02, or 03 holes *combined* is 295.

Our estimate also makes the situation at Cecil comparable to what we found for the Air Force in the earlier research [1]. Combining the averages for IPG I and II due-outs from Table 3-2, we estimate 558 [(295 + 821)/2 = 558] outstanding high-priority due-outs at Cecil for DISC items at any given time. That number is comparable in order of magnitude with the 300 to 1,500 priority group I and II due-outs for DLA items we observed at Air Force bases in [1].

As noted earlier, Cecil was achieving 76 percent POE supply effectiveness for "9 Cog" (i.e., DLA-managed) materiel in 1989. That, too, is comparable to retail supply performance at Air Force bases for DLA materiel. The fact that retail supply performance at Cecil Field in 1989 was comparable to retail supply performance at Air Force bases during the same period supports the view that the readiness effects estimated in [1] for Air Force aircraft can be proportionally estimated for Navy aircraft.

The rule of thumb derived in [1] for the Air Force was that every 5 percent increase in DLA wholesale unit backorders for WSSP/Air Force items (corresponding to a $10 million reduction in DLA safety levels for those items) would add 6 to 8 more NMCS/PMCS aircraft to the Air Force average of 1,300 NMCS/PMCS aircraft. The figure of 1,300 aircraft is based on the Air Force's overall Mission Capable (MC) rate in 1989, which was about 85 percent for a total Air Force fleet of about 9,100 aircraft.

The Navy had roughly 2,500 aircraft in 1989 and a Navy-wide aircraft MC rate that fell between 80 and 90 percent. The proportional rule of thumb for the Navy, therefore, is that a 5 percent increase in wholesale unit backorders at DLA would mean about 2 more NMCS or PMCS Navy aircraft. That figure is derived by multiplying the Air Force effect by the ratio 2,500/9,100. The 2 more NMCS/PMCS

aircraft in the Navy are in addition to the 6 to 8 additional NMCS/PMCS aircraft in the Air Force.

MULTI-ECHELON SUPPLY MODELING AT DLA

A third reason for DLA to be interested in retail supply data, besides their usefulness in identifying nonstocked items and the role they play in estimating readiness effects, has to do with DLA's involvement in the DoD CIM effort. As part of the CIM initiative, DLA is working with the Services to establish "multi-echelon" supply requirements determination methodologies for secondary items – including consumables.

In DoD, a multi-echelon supply model *by definition* is one that finds the best (i.e., lowest cost) mix of wholesale and retail stock levels to achieve a given or required level of supply performance *at the retail level*. A key element of the multi-echelon "philosophy" is to get *upper* supply echelons to focus on *lower* echelon performance.

Thus, if DLA tries to convert to a multi-echelon approach for consumables, it will be trying to minimize *retail-level* supply due-outs. That is not what DLA does today. Today, DLA runs a single-echelon requirements model that tries to minimize outstanding *wholesale-level* backorders for a given investment in wholesale inventory. In the multi-echelon setting, the goal will be to minimize retail-level due-outs for a given investment in wholesale and retail inventory combined.

Multi-echelon methods for DLA are worth pursuing, to make sure that what DLA saves at the wholesale level does not wind up costing the Services extra in what they stock at the retail level. Of course, DLA does not control retail levels; the Services do. However, methods for achieving multi-echelon efficiencies in "uncoupled" systems (i.e., systems in which different organizations control stock levels at the various supply echelons) have been proposed (in [18], for example). Thus, DLA should continue its pursuit of multi-echelon methods.

The point is that as DLA pursues multi-echelon methods, it will need to think about and collect data on retail-level demand and performance, in addition to the wholesale-level demand and performance data it currently collects about its own operations.

CHAPTER 4

SYSTEM SAFETY LEVELS BY WEAPON SYSTEM

OVERVIEW

This chapter and the next are about "system" safety levels at DLA – what they are, how they are calculated, and alternative ways DLA can compute them to improve support to weapon-system readiness. Because SAMMS already employs a system-oriented approach, the basic arithmetic is not new. What is new is the idea of using different systems of items when performing safety level calculations.

A system of items is simply a collection of items that have something in common. Examples are the DLA-managed consumables applying to a weapon system like the Navy's F-14 fighter, the Army's M1-A1 tank, or the Advanced Medium-Range Air-to-Air Missile (AMRAAM); the collection of items managed by a commodity-oriented DLA hardware center; all of the demand-based items in DLA's Weapon System Support Program (WSSP); all of the hardware items managed by DLA that have had at least three requisitions in the last year; and the (gigantic) system of items consisting of all the demand-based consumable hardware items DLA manages, together with all the demand-based depot-level-reparable items the Services manage.

By "system safety level calculations" we mean safety level calculations that are done for an entire system of items as opposed to calculations done for one item at a time. DLA already does system calculations. At each DLA hardware center, SAMMS calculates safety levels for the system of demand-based items the center manages. [Demand-based items are identified as Item Category Code (ICC) "1" items in SAMMS files.]

The system calculation in SAMMS is designed to find the best (lowest cost) mix of safety levels to achieve a given or required level of performance at the center. The main measures of performance are the supply availability rate (the percentage of requisitions the center is able to fill over a given period) and the average number of outstanding backorders (again measured over some period of time).

The idea of system calculations is to maximize performance for a collection of items rather than trying to specify or control supply performance for each item individually. In such calculations, supply performance for the system is controlled by allowing safety levels to vary from item to item, depending on the demand, demand variance, and cost of each item. The system approach makes a supply system more efficient (i.e., able to achieve a given level of *system* supply performance at less cost than other approaches would require).

Over the years, the term "variable safety level" (VSL) has been used to identify safety levels calculated using the system approach. Since the early 1970s, official DoD supply policy [19] has called for the use of VSL models because of their efficiency. A new draft directive on DoD supply management [20] continues that tradition when it talks about minimizing the "total variable cost" for "groups" of items.

Given that the system approach is here to stay, the question for DLA is: what "systems" should DLA use when computing safety levels? Grouping items by weapon system when computing safety levels lies at the heart of weapon-system-oriented supply management of secondary items. On the other hand, DLA's current commodity-oriented approach offers opportunities for large-scale optimization that can make DLA more efficient. The problem for DLA is to find the right balance between weapon-system grouping and commodity grouping.

The choice is not clear-cut. Evidence discussed in the next chapter has emerged suggesting that weapon-system grouping looks promising only because DLA has evolved away from true, large-scale system optimization. With some modifications in its current commodity-oriented approach, DLA may well be able to fully support weapon-system readiness without having to adopt weapon-system grouping for computing safety levels. That is particularly true if DLA acts on the recommendations presented earlier to identify and support two classes of items that have particular leverage on weapon-system readiness: consumable LRUs and items not universally stocked in retail systems.

The results in this chapter and the next are important for DLA's work with the JLSC as well. Weapon-system-oriented management of secondary items is one of the key focus areas in the CIM/JLSC effort. Pressure on DLA to do some form of weapon-system grouping in safety level calculations is inevitable. This chapter and the next

give DLA important facts for the JLSC discussions that need to be considered in trying to find the right balance between weapon-system grouping and commodity grouping.

A final point: no matter which item groups are defined for computing safety levels, those groups do *not* have to define how the items are grouped for other management purposes. Many DLA managers already recognize that computing system safety levels is an *information exchange* challenge, not one of organization. If DLA does eventually single out weapon-system items for computing safety levels, it will need to modify the way it measures and evaluates supply performance. Centers will need to distinguish between WSSP supply availability and non-WSSP supply availability, for example. Again, that does not require structural reorganization. Improved system safety level calculations for better support to readiness can be accommodated no matter how DLA chooses to reorganize itself to meet changing conditions.

WEAPON SYSTEM RESULTS

A Review of the F-16 Experiment

In [1] we performed an experiment on the 19,845 items in the WSSP in March 1989 that applied to the Air Force's F-16 weapon system. We did a system safety level calculation for that particular group of items and compared the results to those achieved through the use of existing SAMMS safety levels. We will describe the experiment, because we repeated it exactly for 20 more weapon systems in addition to the F-16.

To do a system safety level calculation for F-16 items, we needed to specify a supply performance target for the system.[1] Following standard DoD policy and practice, that meant we needed to specify the maximum number of outstanding wholesale-level backorders that could be viewed as being "acceptable" for the system.

[1]As described in [19], system safety level calculations involve solving a constrained optimization problem in inventory theory: For a system of items, find the set of safety levels and order quantities that minimizes ordering and holding costs for the system, subject to a constraint on the average number of outstanding backorders. A supply performance "target" for the system is set by specifying a system backorder constraint. The more backorders that can be tolerated, the lower the system costs, and vice versa.

An important point here, discussed further in the next chapter, is that we used a *unit* backorder target rather than a *requisition* ("line") backorder target for the system.

We established an acceptable unit backorder target for WSSP F-16 items in the following way: At the end of March 1989, SAMMS files contained the established DLA safety levels for the F-16 items in our experiment. For each item we performed a calculation, using arithmetic essentially identical to the arithmetic in SAMMS, to derive the expected number of outstanding unit backorders (unit EBOs) for the item that result from the official SAMMS safety level. In effect, we determined the unit EBOs for the item that DLA's safety level implicitly defined as "acceptable."

We then summed the unit EBOs across the 19,845 F-16 items in the system. That sum became the target for the system. Logically, the sum represents the implicit backorder target for F-16 items at DLA.

We then performed a SAMMS-like system safety level calculation[2] for F-16 items, using the new target. In our calculation, we followed the same rules that DLA follows when setting safety levels: Negative safety levels are reset to zero, and positive safety levels are allowed to be no greater than expected leadtime demand or three standard deviations in leadtime demand, whichever is smaller. These rules are in accordance with DoD-wide supply policy in [19] and [20].

The results in [1] for F-16 items were impressive: It appeared possible to reduce the SAMMS safety level requirement for F-16 items in the WSSP by $20 million (from $30 million to $10 million) while simultaneously reducing unit EBOs from 745,000 to 550,000. Chapter 3 in [1] describes how and why this happens. The job here is to see whether similar results hold for other weapon systems. We also want to examine common-component effects.

Multiple-Weapon-System Results

As noted, we repeated the F-16 experiment for the F-16 and 20 other weapon systems, this time using SAMMS data from March 1990. Table 4-1 sets forth the results. In virtually every case, we found it possible to reduce safety level

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[2]The mathematics in a system safety level calculation is the same no matter how big or small the system is. All that changes are the summation indices corresponding to the number of items in the system. The mathematics is described in DLA SAMMS documentation [13]. The DLA SAMMS methodology follows the fourth method ("Model IV") described in [21].

requirements while simultaneously reducing the expected number of outstanding wholesale-level unit backorders for the system.

TABLE 4-1

WEAPON-SYSTEM RESULTS

Weapon system/ WSSP code	No. of WSSP NSNs	SAMMS safety level ($ millions)	SAMMS unit EBOs	LMI safety level ($ millions)	LMI unit EBOs	Safety level effects after reconciling for common components ($ millions)	Unit EBOs	Actual outstanding unit backorders March 1990
Army								
Chinook helicopter/05A	8,440	22.02	220,522	8.13	185,640	8.96	175,179	2,554,153
TOW missile . 2A	2,777	5.70	47,848	2.00	46,960	2.38	42,330	582,727
M1 Abrams tank/36A	4,339	7.25	135,052	2.52	122,911	3.63	101,281	1,027,874
Bradley Fighting Vehicle/37A	5,118	11.73	120,902	3.60	98,859	4.26	89,798	1,436,741
Patriot missile/39A	5,553	16.51	126,263	5.43	115,655	5.43	115,652	761,902
Navy								
Poseidon material/03N	61,217	106.97	737,147	31.75	549,002	31.77	548,431	4,270,098
F-14 *Tomcat*/10N	9,252	19.83	325,459	7.25	221,086	8.94	195,675	2,931,526
Navy Nuclear Reactors/21N	13,571	19.43	239,894	6.10	185,139	8.66	148,615	1,341,422
Harrier AV-8B/55N	12,221	20.79	460,222	7.78	261,472	9.36	232,837	4,031,245
MK48 torpedo	2,550	6.51	99,115	2.55	81,628	3.77	59,779	617,493
Marine Corps								
Airborne Mobile Dir. Air Support Control/ABM	1,916	5.91	57,779	2.41	57,584	2.79	52,390	371,901
Portable Team Dir Finder/AZM	453	0.77	7,939	0.37	8,378	0.45	6,956	88,560
Imagery Interpretation Facility/BKM	1,774	5.64	73,756	2.51	72,835	3.12	62,232	614,465
Radar Set, Firefinder/BPM	2,144	6.70	139,595	2.61	131,385	3.59	111,942	809,515
Fleet Satellite Comm. Terminal/G4M	476	1.87	15,915	0.56	15,030	0.69	13,371	119,374
Air Force								
B-52/04F	9,153	33.67	404,633	12.38	312,042	15.04	271,316	3,852,083
H-53 Super Jolly heli./16F	4,330	20.41	142,756	8.13	120,770	8.48	116,949	2,057,207
A-10 Thunderbolt/24F	8,485	30.69	345,759	11.68	227,451	13.32	205,086	4,020,074
C-135 Stratolifter/05F	20,205	46.98	569,854	16.91	456,341	20.54	401,952	6,161,804
AMRAAM Missile/ADF	656	1.82	24,097	0.80	24,689	0.99	20,881	315,325
F-16/26F	19,259	31.17	371,832	11.83	321,560	14.32	285,031	4,815,318

Common Component Effects

Many DLA-managed items are used by more than one weapon system. That poses a problem when using weapon-system groups in computing safety levels, because any component that applies to more than one weapon system will show up in more than one group. When that happens, it is highly likely that the computed safety

level requirement will vary from system to system. The component is only one component, however, and can only have one safety level in SAMMS.[3] That means a decision must be made about which safety level to use. To demonstrate common-component effects, Table 4-1 includes two columns that show what happens to costs and unit EBOs when safety levels for common components are reconciled across the multiple systems.

According to application information in the March 1990 WSSP file, the weapon systems in Table 4-1 all share some DLA items. Some weapon systems share many items. The costs in the "after reconciling" column were obtained by replacing the weapon system safety level with the biggest safety level the component received across all systems in the table. Comparing the costs and unit EBOs in that column and the next with those in the two "SAMMS" columns shows that even after reconciling for common-component effects, weapon-system grouping is still able to do better than current SAMMS safety levels both in cost and performance.

Is Weapon System Grouping a Good Idea?

The results in Table 4-1 would seem to suggest that DLA should immediately begin grouping items by weapon system when computing safety levels. We are not recommending that DLA do this, however. Before DLA can consider grouping by weapon system, it must wring out any inefficiency it has in its current system. For reasons described below, we believe that the results in Table 4-1 are a measure of problems in the current system more than they are a measure of the benefits of weapon-system grouping. If DLA were truly doing large-scale inventory system optimization, it would be more expensive, not less, to compute safety levels by weapon system, contrary to what Table 4-1 appears to indicate.

To see why this is so, we first need to simplify our experiment with weapon-system grouping. In the next section, we split the items at a DLA hardware center

[3]As prescribed in [22] for common components, no matter how many weapon systems contain a component, the component's total worldwide demand from *all* using systems must be used in each of the weapon system calculations, as if all the demand for the item were coming from that weapon system. That is the correct and necessary policy for common components. The correct (and only) role of point-of-sale demand information by weapon system is to prorate the unit EBOs calculated using total demand. As discussed in [1], DLA's need for demand-by-weapon-system information from the Services is for such point-of-sale demand information.

into two groups – WSSP items and non-WSSP items – and perform system safety level calculations for each group.

GROUPING BY WSSP/NON-WSSP AT A CENTER

As an alternative to grouping by individual weapon system, DLA can consider simply grouping all WSSP items together for system safety level calculations at each hardware center. Doing that would satisfy the pressure to do weapon-system grouping while avoiding the complexities of grouping by individual system. (The results in Table 4-1 took time and effort to assemble and cover only 21 weapon systems. As of the end of January 1989, the WSSP was supporting 1,109 distinct weapon systems: 452 in the Army, 203 in the Navy, 206 in the Air Force, and 248 in the Marine Corps.)

To see what would happen if DLA simply were to group WSSP and non-WSSP items separately, we performed the same experiment done for individual groups of weapon-system items on the entire set of 49,600 WSSP items at the Defense General Supply Center (DGSC) in Richmond, Virginia. (We chose DGSC because it manages the smallest number of WSSP items among the four hardware centers, making system calculations with a personal computer more tractable.)

Table 4-2 sets forth the results for the 49,600 WSSP items at DGSC in March 1990.

TABLE 4-2

GROUPING WSSP ITEMS AT DGSC – MARCH 1990 DATA

(49,600 items)

March 1990 SAMMS safety level ($ millions)	SAMMS[a] EBOs (units)		LMI safety level ($ millions)	LMI[a] EBOs (units)
156.5	379,000		41.8	362,000

[a] These are computed unit EBO values from a mathematical inventory model. At DGSC at the end of March 1990 there were 2,831,199 outstanding unit backorders.

For the record, the actual number of outstanding wholesale-level unit backorders for DGSC WSSP items at the end of March 1990 was 2,831,199 unit backorders, according to SAMMS data in the DIDB. [*Note:* Readers may be justifiably puzzled why the computed EBOs in Table 4-2 are so much smaller than actual outstanding backorders. In [1] we discuss the existence of "unexpected" backorders at DLA to explain, at least in part, why *computed* numbers of expected outstanding backorders tend to be smaller than *actual* outstanding backorder quantities.]

If, for the WSSP items at each of its hardware centers, DLA could achieve a reduction in average outstanding wholesale unit backorders similar to the almost 5 percent reduction in unit EBOs shown in Table 4-2, that would translate into measurably better support to weapon-system readiness. Using the rule of thumb from [1] for the Air Force and its extension to Navy aircraft in Chapter 2 of this report, a 5 percent reduction in wholesale unit EBOs for WSSP items at DLA would *remove* six to eight aircraft in the Air Force and two aircraft in the Navy from NMCS/PMCS rolls . The readiness of Army and Marine Corps weapon systems would also benefit.

But, before we recommend that DLA employ WSSP grouping, we have to ask what happens to non-WSSP items? Are we improving weapon system support at the expense of non-WSSP items?

If WSSP items are grouped at DGSC, then non-WSSP items become their own group for safety level calculations. To see what happens, we did a system safety level calculation for the 56,943 non-WSSP items at DGSC in March 1990. Again, we used the item backorders resulting from SAMMS safety levels to assemble a system unit backorder target for the system, and we applied the standard SAMMS safety level constraints. Table 4-3 contains the results.

The actual number of outstanding wholesale-level unit backorders for DGSC non-WSSP items at the end of March 1990 was 1,167,676 unit backorders.

What is odd about Table 4-3 is that if we add its cost and backorder figures to those in Table 4-2, we get fewer backorders *and* lower costs for the *entire* collection of demand-based items at DGSC, as shown in Table 4-4. The mathematics of system optimization, however, makes it impossible to do better for a large group of items by breaking it into two smaller groups, doing system optimization on each, and then

adding the results. Therefore, the results in Table 4-4 imply that LMI and DGSC could not have done the same system calculation.

TABLE 4-3

GROUPING NON-WSSP ITEMS AT DGSC – MARCH 1990 DATA

(56,943 items)

March 1990 SAMMS safety level ($ millions)	SAMMS[a] EBOs (units)		LMI safety level ($ millions)	LMI[a] EBOs (units)
98.7	2,658,000		7.6	997,000

[a] Computed unit EBO values. Actual outstanding unit backorders for non-WSSP items at the end of March 1990 amounted to 1,167,676.

TABLE 4-4

COMBINING WSSP AND NON-WSSP RESULTS FOR DGSC – MARCH 1990 DATA

(49,600 + 56,943 = 106,543 items)

March 1990 SAMMS safety level ($ millions)	SAMMS[a] EBOs (units)		LMI safety level ($ millions)	LMI[a] EBOs (units)
156.5 + 98.7 = 255.2	379,000 + 2,658,000 = 3,037,000		41.8 + 7.6 = 49.4	362,000+ 997,000 = 1,359,000

[a] Computed unit EBO values. Actual unit backorders outstanding at DGSC at the end of March 1990 totaled 3,998,875.

The results in Table 4-4 force us to look at SAMMS safety level calculations for the full system of demand-based hardware items at DGSC – before we can recommend WSSP safety level grouping to DLA. We need to see where LMI system calculations agree with those at DGSC and where and how they disagree. That is the subject of the next chapter.

CHAPTER 5

SYSTEM SAFETY LEVELS BY COMMODITY

OVERVIEW

In this chapter we show the results of "whole-system" safety level calculations for DGSC. Our method is the same one used in our previous system calculations: We assemble system unit backorder targets based on actual SAMMS safety levels and then apply the usual safety level constraints to the results of the system calculation (i.e., each item's safety level must be nonnegative but no greater than leadtime demand or three standard deviations in leadtime demand, whichever is smaller).

The major difference between our calculations and those at DGSC is that we use larger system backorder targets than DGSC has been using. That happens because of the way we derive our system backorder target. It also happens because we deliberately use *unit* backorder targets as opposed to the *requisition* ("line") backorder targets that DGSC uses. In DGSC's defense, it should be noted that DoD supply policy [19] has traditionally required wholesalers to use line backorder targets, as opposed to unit backorders, in system safety level calculations. The relevant phrase in [19] is "time-weighted *requisitions* short," [emphasis ours] which means exactly the same thing as "the average number of outstanding *line* backorders." An important point is that new DoD supply policy as stated in [20] does not explicitly repeat this requirement and, therefore, leaves the door open for the use of "time-weighted *units* short" in system safety level calculations.

Our results suggest that DGSC could reduce safety level requirements *and* reduce outstanding unit backorder levels by doing whole-system safety calculations the way we do them in this report – by adjusting the targets upward; by using unit versus line backorder targets; and by accounting for the interaction between "optimal" system solutions and the imposition of safety level constraints.

We do not attempt to demonstrate conclusively that DLA should adopt the new ideas for full-system calculations; that is the subject of ongoing research at LMI. Our

purpose is simply to report results and explain where and why additional research is necessary.

After reviewing the situation for "whole-system" calculations, at the end of the chapter we do recommend that DLA consider using WSSP grouping for computing safety levels, as described at the end of the previous chapter. One way or another, weapon-system items are going to receive special attention under the new policies emerging for secondary item management. Grouping WSSP items together for system safety level calculations at the hardware centers is a feasible and practical way for DLA to proceed in accordance with the new policies.

WHOLE-SYSTEM CALCULATIONS FOR DGSC

Table 5-1 shows what happens when LMI computes system safety levels for the full set of 106,543 demand-based items at DGSC (49,600 WSSP items and 56,943 non-WSSP items) in March 1990. We are able to substantially reduce the total DGSC safety level requirement and simultaneously improve expected supply performance (unit EBOs). At the lower right, we have reproduced the LMI results from Table 4-4 to show that a full system calculation is, indeed, more efficient than combining separate WSSP and non-WSSP calculations.

TABLE 5-1

DGSC WHOLE-SYSTEM SAFETY LEVELS – MARCH 1990 DATA

March 1990 SAMMS safety level ($ millions)	SAMMS[a] EBOs (units)		LMI safety level ($ millions)	LMI[a] EBOs (units)
255.2	3,037,000		26.4	1,487,000

Previous LMI results when WSSP and non-WSSP computed separately (from Table 4-4)	
49.4	1,359,000

[a] Computed unit EBO values. The actual number of outstanding unit backorders at DGSC at the end of March 1990 was 3,998,875.

The point of Table 5-1 is to show that LMI's "full system" calculation is quite different from the actual DGSC "full system" calculation. We will explain below why the LMI and DGSC results differ so much for the same set of items. First, a little more background.

For the record, at the end of March 1990, there were actually 3,998,875 outstanding wholesale-level unit backorders at DGSC, according to SAMMS data in the DIDB. The system backorder target LMI used in computing the LMI values in the upper right of Table 5-1 was 3,038,835 unit backorders (i.e., a target *smaller* than the actual number of outstanding unit backorders at DGSC in March 1990).

To make sure that the situation we were observing at DGSC in March 1990 was not anomalous, we redid the calculation for all the demand-based (ICC equals "1") items at DGSC in March 1992. [In March 1992, DGSC had 105,956 (ICC equals "1") items – roughly the same number as in March 1990.] The results are shown in Table 5-2.

TABLE 5-2

DGSC WHOLE-SYSTEM SAFETY LEVELS – MARCH 1992 DATA

March 1990 SAMMS safety level ($ millions)	SAMMS[a] EBOs (units)		LMI safety level ($ millions)	LMI[a] EBOs (units)
307.8	2,142,000		54.3	1,933,000

[a] Computed unit EBO values. At DGSC at the end of March 1992 there were actually 3,369,234 outstanding unit backorders.

For the record, the actual number of outstanding wholesale-level unit backorders at DGSC at the end of March 1992 was 3,369,234, according to SAMMS data in the DIDB. The system backorder target we used in computing the LMI values in Table 5-2 was 2,141,688 unit backorders (again, substantially less than the actual number of outstanding unit backorders at DGSC in March 1992).

WHY LMI AND DGSC RESULTS DIFFER

The results in Tables 5-1 and 5-2 suggest that system calculations at DGSC should be reviewed. When the results in Table 5-2 emerged, DORO performed a preliminary analysis [23] to explain the differences between LMI's results and DGSC practice.

The DORO analysis provided some very useful insights. Most importantly, DORO learned that for the March 1992 calculation, DGSC had set its system backorder target at 15,000 *line* backorders. The average requisition quantity at DGSC in 1992 was 28.7 units. If we multiply 15,000 line backorders by 28.7, we get a system target of 430,500 unit backorders. That is substantially smaller than the target of 2.1 million unit backorders we used. Because we used a much larger system backorder target, our computed safety level requirement ($54.3 million) is much smaller than the DGSC requirement ($307.8 million).

In reviewing the DGSC calculation, DORO learned that DGSC's rationale for the 15,000-line-backorder target began with a goal of 90 percent line supply availability at the center: with that supply availability, and assuming an average of 150,000 requisitions per quarter, DGSC computed that it would backorder 15,000 requisitions per quarter. A problem, however, is that the number of backorders occurring in a given period *is not the same as the average number of outstanding backorders*. The latter is what the system backorder target is supposed to be.[1]

Another key DORO finding was that in the DGSC safety level calculations, 56.5 percent of ICC "1" items (and 62.2 percent of critical weapon-system items) had their computed safety level reset to conform to the leadtime constraint. In other words, most of the safety levels originally computed using an optimizing algorithm were being reduced. That, of course, changes the expected supply performance for the system. With lower safety levels for more than half the items, expected outstanding unit backorders *increase*. We simply took the new, larger quantity of expected unit

[1]Time weighting makes the difference. For example, with a demand rate of 1,667 (150,000/90) requisitions per day, if 166 requisitions are backordered each day (corresponding to a 90 percent fill rate and 15,000 backordered requisitions per quarter) and each of those backorders lasts an average of 650 days, the average number of outstanding line backorders would be 166 × 650 = 107,900 (not 15,000). Assuming an average quantity of 30 units per requisition, 107,900 outstanding line backorders converts to 3.2 million outstanding unit backorders (about what DGSC had at the end of March 1992).

backorders as the system target and computed a better way to achieve *it*. What is still unclear (and part of what the new research will address) is whether iterating in this way (i.e., optimize the system, constrain it, optimize again, constrain that solution, optimize again, . . .) converges to a stable set of safety levels. Even if it doesn't, the evidence from DGSC suggests that it is worth running the calculation at least twice, as we did.

At the end of its report, DORO concluded that system backorder goals at the hardware centers should be reviewed.

UNIT VERSUS LINE BACKORDERS

Multiplying by average requisition quantities is the way to convert line backorders to unit backorders. An examination of the SAMMS safety level formula (see Equation 2-1 in Chapter 2) shows that the use of line backorders in SAMMS safety level calculations biases DLA safety levels in favor of items with small average requisition size. The larger the average requisition size (S_i in Equation 2-1), the smaller the safety level will be for the item in question.

In the past, this practice has been justified with the argument that critical items tend to have smaller requisition size – because critical items are assumed to be more expensive and users tend not to requisition large quantities of expensive items. Part of the new research will be to address the concern that if unit backorders replace line backorders, the effect will be to under-support "critical" items.

On this point, Table 2-1 in Chapter 2 of this report is instructive. Every item in Table 2-1 is a consumable F-15 LRU and can therefore be viewed as "critical." The table suggests that while there probably is a correlation between average requisition size and unit cost, neither cost nor average requisition size is a particularly good indicator of "criticality." Rather than relying on cost and average requisition size as surrogates for "criticality," DLA should identify critical items directly – by identifying consumable LRUs as recommended in this report.

Putting aside the criticality question, another concern is simply that using unit instead of line backorders will "buy too many cheap items" (because of the correlation between average requisition size and cost). This concern is akin to the traditional concern that VSL models are biased in favor of cheaper items. As discussed in [1] (see

the discussion in Chapter 3 of that report), that concern really has to do with defining the system of items appropriately.

To illustrate, today, DLA groups weapon-system and non-weapon-system items together in its system safety level calculations. It then attempts (using average requisition size adjustments) to make sure that too many "cheap" non-weapon-system items are not bought at the expense of (presumably) more expensive weapon-system items. The better alternative would be to simply separate weapon-system items from non-weapon-system items when performing system safety level calculations.

It is true that items with widely varying costs probably should not be included in the same system calculation. Unless the item data are very reliable (which they never are), VSL methods do run the risk of overbuying 10 cent items and underbuying $1,000 items, if those items are included in the same calculation and have similar demand patterns. That is a powerful reason why "cheap" consumables should generally not be included with "expensive" depot-level reparables in system models. Even among consumables, if DLA is concerned about the tradeoff between expensive and cheap items, perhaps DLA should separate the expensive items from the cheap ones and do the system calculations separately.

RECOMMENDATIONS

We recommend that DLA take the following steps:

Recommendation 6

Undertake a review of system safety level calculations at its four hardware centers with a view to improving supply performance while reducing safety level requirements and resulting replenishment costs. The review should include consideration of appropriate system backorder targets, the use of unit versus line backorders in system safety level calculations, and the interaction between safety level constraints and optimal solutions.

Recommendation 7

Make the necessary changes so that system safety level calculations can be performed for WSSP and non-WSSP items separately. This will accom-

modate the move to weapon-system-oriented management and should be pursued as a near-term JLSC improvement initiative.

GENERAL COMMENTS

The Defense Logistics Agency has asked LMI to conduct the review called for in Recommendation 6. We will propose new system backorder targets for the centers. We will evaluate whether using unit versus line backorders in system safety level calculations will "buy too many cheap items." Also, we will examine the effect on traditional, requisition-oriented supply measures (line availability and line backorders) if the centers begin using unit backorders in setting system performance targets.

For more than 20 years, wholesale supply organizations in DoD have been trying to maximize *requisition* supply availability rates. That habit makes them reluctant to consider whether that "business practice" is really the best way to support readiness. Materiel management business practices are being re-evaluated as part of the CIM initiative, and the traditional focus on requisition fill rates is a prime candidate for re-evaluation.

Recommendation 7 is straightforward to implement – no new computational algorithms are required. The only change is that instead of system calculations being performed on a single large group of items (WSSP and non-WSSP items together), they will be performed on WSSP and non-WSSP items separately. Initially, that means grouping WSSP and non-WSSP items separately at each commodity center. Ultimately, with the projected consolidation of ICP functions, all WSSP items regardless of commodity should be grouped together when computing weapon-system safety levels.

If DLA acts on Recommendation 7, managers will have to make a macro-level resource allocation decision they have not had to make in the past: They will have to decide what the budget should be for WSSP items and what it should be for non-WSSP items. In the past, with all items thrown together in a single system calculation for an entire center, this decision has been "handled" at the micro level. The attempt has been made to use item essentiality codes to try to distinguish between items that, from a weapon-system-support perspective, had no business being in the same group in the first place. In transition, as a practical way to proceed,

the current dollar amounts allocated to WSSP items could serve as the WSSP budget, and similarly for non-WSSP items.

Such allocation decisions will be important if DLA is to avoid "overdoing it" for weapon-system items and not allocating enough funding for other materiel. Given the new missions DoD is being asked to perform, it may be that proper supply support for items that don't go on weapon systems (e.g., barbed wire, sandbags, water pumps, and 2×4s) will be as important as support for items that do.

GLOSSARY

AAM	=	Aircraft Availability Model
AFB	=	air force base
AFLC	=	Air Force Logistics Command
AFMC	=	Air Force Materiel Command
ALC	=	Air Logistics Center
AMC	=	Army Materiel Command
AMRAAM	=	Advanced Medium-Range Air-to-Air Missile
AMSAA	=	Army Materiel Systems Analysis Activity
API	=	Application Program Indenture (Air Force)
APL	=	Allowance Parts List (Navy)
ASL	=	Authorized Stockage List (Army)
ASO	=	Aviation Supply Office (Navy)
AVCAL	=	Aviation Consolidated Allowance List (Navy)
AWP	=	awaiting parts
CASREP	=	Casualty Report (Navy)
CCSS	=	Commodity Command Standard System (Army)
CDDB	=	Central Demand Data Base (Army)
CIM	=	Corporate Information Management
CNA	=	Center for Naval Analyses
COSAL	=	Coordinated Shipboard Allowance List (Navy)
DARPA	=	Defense Advanced Research Projects Agency
DEN	=	Data Element Number (Navy)
DEPRA	=	Defense Program for the Reutilization of Assets

DGSC	=	Defense General Supply Center
DIC	=	Document Identifier Code
DIDB	=	DLA Integrated Data Bank
DISC	=	Defense Industrial Supply Center
DLA	=	Defense Logistics Agency
DoDAAC	=	DoD Activity Address Code
DORO	=	DLA Operations Research Office
DRAMA	=	Data Review, Analysis, and Monitoring Aid (DLA)
DS4	=	Direct Support Unit Standard Supply System (Army)
DSN	=	Defense Switched Network
EBO	=	expected backorder
EOQ	=	economic order quantity
ERRC	=	Expendability, Recoverability, Repairability Category
FLSIP	=	Fleet Logistics Support Improvement Program (Navy)
FMSO	=	Fleet Material Support Office (Navy)
ICC	=	Item Category Code
ICP	=	inventory control point
INDCOD	=	indenture code
IPG	=	issue priority group
JCS	=	Joint Chiefs of Staff
JLSC	=	Joint Logistics Systems Center
LCA	=	Logistics Control Activity (Army)
LIF	=	Logistics Intelligence File (Army)
LMI	=	Logistics Management Institute
LRU	=	line replaceable unit (Army and Air Force)
LSAR	=	Logistics Support Analysis Record
MASS	=	MICAP Asset Sour[illegible] System (Air Force)

MC	=	mission capable
MIC	=	Mission Impact Code
MICAP	=	mission capability
MIL-STD	=	military standard
MMSR	=	Master Materiel Support Record (D049) (Air Force)
MSC	=	Major Subordinate Command (Army)
MVIS	=	Material Visibility (Navy)
NADEPVIS	=	Naval Aviation Depot Visibility
NAVSUP	=	Naval Supply Systems Command
NHA	=	next higher assembly
NIIN	=	national item identification number
NMC	=	not mission capable
NMCS	=	not mission capable–supply
NORS	=	not operationally ready – supply
NSN	=	national stock number
O-level	=	organizational-level
ODS	=	Operations Desert Storm and Desert Shield
OSC	=	Objective Supply Capability (Army)
OSMIS	=	Operating and Support Management Information System (Army)
PCCN	=	Provisioning Contract Control Number
PLISN	=	Provisioning List Item Sequence Number
PLL	=	Prescribed Load List (Army)
PMC	=	partially mission capable
PMCS	=	partially mission capable–supply
PMR	=	Provisioning Master Record (Navy)
POE	=	Point-of-Entry (Navy)
PSI	=	Program Support Interest (Navy)

PXR	=	Provisioning Cross-Reference (Army)
RDB	=	Requirements Data Bank (Air Force)
RIC	=	Repairable Item Code (Navy)
SAILS	=	Standard Army Intermediate Level Supply (Army)
SAMMS	=	Standard Automated Materiel Management System (DLA)
SASSY	=	Supported Activities Supply System (Marine Corps)
SBSS	=	Standard Base Supply System (Air Force)
SIMA	=	Systems Integration and Management Activity (Army)
SMR	=	Source, Maintenance, and Recoverability
SPCC	=	Ships Parts Control Center (Navy)
SSC	=	Standard Systems Center (Air Force)
SSD	=	Systems Support Division (Air Force)
TAV	=	total asset visibility
UICP	=	Uniform Inventory Control Point (Navy)
UMMIPS	=	Uniform Materiel Movement and Issue Priority System
UND	=	Urgency of Need Designator
VMSIR	=	Virtual Master Stock Item Record
VSL	=	variable safety level
WRA	=	weapon replaceable assembly (Navy)
WSF	=	Weapon System File (Navy)
WSIC	=	Weapon System Indicator Code (DLA)
WSSP	=	Weapon System Support Program (DLA)

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APPENDIX

SUMMARY OF RECOMMENDATIONS

LMI's work on relating inventory investment at the Defense Logistics Agency (DLA) to operational availability has led to seven recommendations for DLA action, which are summarized in this appendix. The recommendations propose DLA action in three areas of opportunity: **Consumable Line Replaceable Units (LRUs), Tracking Retail Data,** and **System Safety Levels**. Details of the supporting analysis appear in the main body of the report.

Each set of recommendations is aimed at improving DLA's support of weapon system readiness while controlling or reducing wholesale replenishment costs. The goal in every case is to help DLA do a better job of supporting its customers. Each recommendation contains actions DLA can take in the near term.

After the recommendations are "general comments" on their management ramifications.

LMI RECOMMENDATIONS

Consumable LRUs

The first four recommendations relate to the identification and treatment of consumable LRUs. These are DLA-managed items that apply *directly* to weapon systems rather than being repair parts for other, reparable-type weapon-system components.

For consumable LRUs, LMI recommends that DLA

1. Identify and place more focus on consumable LRUs (something DLA does not currently do). To identify consumable LRUs, DLA should use third-position Source, Maintenance, and Recoverability (SMR) codes in combination with Logistics Support Analysis Record (LSAR) indenture codes for item/weapon-system combinations of interest.[1]

[1] Weapon systems of interest are systems DLA supports in its Weapon System Support Program (WSSP). As of January 1989, the WSSP was supporting 1,109 distinct systems: 452 in the Army, 203 in the Navy, 206 in the Air Force, and 248 in the Marine Corps.

2. As SMR and indenture data are obtained, register consumable LRUs in the Weapon System Support Program (WSSP) (if they are not already registered). Establish a new item classification scheme to complement existing "item essentiality" codings by identifying consumable LRUs with their own new (or modified) data element. Items used on more than one weapon system should receive the consumable LRU classification if they are a consumable LRU in any of their applications.

3. Insert an "LRU factor" into the formula used to compute wholesale safety levels. The LRU factor should be a multiplicative adjustment factor applied to the item essentiality factor already in the formula. For consumable LRUs, the LRU factor should be 1.0; for non-LRUs, the factor should be slightly less than 1.0.

4. Take the necessary steps within the Joint Logistics Systems Center (JLSC) framework of "business process improvements" to ensure that DLA can obtain, store, and use both third-position SMR data and LSAR-type indenture data for item/weapon-system combinations of interest.

Tracking Retail Data

By tracking retail stockage as suggested in the next recommendation, DLA can better support readiness across the board without spending any more on wholesale stockage.

For tracking retail data, LMI recommends that DLA

5. Develop the capability (for all hardware items) to generate (or maintain on a continuing basis) an automated file for each national stock number (NSN) that lists, by DoD Activity Address Code (DoDAAC), the retail supply points in the Army, Navy, and Air Force that do and do not stock the given NSN. To use this information, DLA should arrange that when a high-priority requisition is received that cannot be filled, the requesting site is automatically supplied with a list of retail sites that do stock the item.

System Safety Levels

The Defense Logistics Agency computes system safety levels for groups of items in order to achieve targeted levels of supply performance for least cost. Recommendation 6 addresses system safety level calculations as they are currently performed. Recommendation 7 relates system calculations to the DoD mandate to adopt weapon-system-oriented methods for secondary item management.

For system safety level calculations, LMI recommends that DLA

6. Undertake a review of system safety level calculations at its four hardware centers with a view to improving supply performance while reducing safety level requirements and resulting replenishment costs. The review should include consideration of appropriate system backorder targets and the use of unit backorders in lieu of requisition ("line") backorders in system calculations.

7. Make the necessary changes so that separate system safety level calculations can be performed for WSSP and non-WSSP items. This will accommodate the move to weapon-system-oriented management and should be pursued as a near-term JLSC improvement initiative.

GENERAL COMMENTS

Consumable LRUs

Recommendation 1, to identify and focus on consumable LRUs, is motivated by the findings that (1) consumable LRUs have greater proportionate influence on weapon-system readiness rates than do other DLA-managed items and (2) consumable LRUs can be successfully identified by using a *combination* of standard data elements (SMR codes and LSAR-type indenture codes) already present in existing Army, Navy, and Air Force logistics data systems.

"Items of interest" in the search for consumable LRUs include *all* DLA-managed hardware items, both demand-based and non-demand-based, whether or not they are registered in the WSSP. Consideration of all such items makes retrieval of SMR and indenture codes for item/weapon-system combinations easier and will help to improve the integrity of WSSP data.

Recommendation 2, to register identified consumable LRUs in the WSSP, is based on the idea that all the weapon-system items DLA manages should be in the WSSP, *particularly* if they are consumable LRUs. That is not currently the case. For example, 813 (44.3 percent) of 1,834 consumable LRUs identified for the F-15 were not registered in the WSSP as of March 1990.

Current DLA procedure is to place an item in the WSSP only if formally requested to do so by one of the Services. Adopting Recommendation 2, therefore, entails a policy decision by DLA to update the WSSP file on its own (using SMR and indenture data it collects itself) rather than waiting for Service requests. For DLA to make such a decision would be consistent with the emerging Corporate Information

Management (CIM) policy concerning the treatment of weapon-system items. It would also be consistent with Recommendation 7 that weapon-system items should be one of the defining groups DLA uses when computing *system* safety levels.

The LRU factors suggested in Recommendation 3 for adjusting safety levels (1.0 for LRUs, less than 1.0 for non-LRUs) would leave safety levels unchanged for consumable LRUs and reduce them slightly for non-LRUs. The evidence says that consumable LRUs constitute less than 10 percent of the items in the WSSP. Use of the recommended LRU factors, therefore, gives DLA a way to maintain support for items that have the greatest leverage on readiness (consumable LRUs) while prudently reducing replenishment requirements for large numbers of non-LRU items at the four hardware centers.

Recommendation 4, to take the necessary steps in the CIM/JLSC process to ensure that DLA will be able to get and use SMR and indenture data, is motivated by the fact that identification of consumable LRUs is a necessary prerequisite for successful implementation of weapon-system-oriented secondary item management.

Neither the Standard Automated Materiel Management System (SAMMS) nor the WSSP file currently receive or have the capability to store third-position SMR maintenance codes or LSAR-type indenture codes for item/weapon-system combinations of interest. Further, it is not clear that such a capability can be incorporated into SAMMS and the WSSP under current DoD funding allocations for "maintenance and operation" of existing data processing systems. The job of putting the new information into the current system (which *would* be a way to achieve improvements sooner) would have two parts: getting the data from the Services and modifying SAMMS and WSSP files to hold the data. That would require establishing procedures for receiving Service data (from Service files that have different structures), processing the data, loading the data into SAMMS and the WSSP file, and periodically updating the data. Such changes may not be possible under current DoD/CIM constraints on system development. Thus, it is important that DLA take steps to ensure that in future CIM/JLSC systems, the capability will exist to obtain third-position SMR data and LSAR-type indenture data and maintain them in the DLA system.

[*Note:* For newer systems, DLA may wish to tap MIL-STD-1388-2B LSAR records *directly* to obtain SMR and indenture data. Both of the required data elements are part of the standard LSAR "H1" data record. The joint DLA/Defense Advanced Research Projects Agency (DARPA) Data Review, Analysis, and Monitoring Aid (DRAMA) project is aimed at providing direct access to LSAR data bases.]

Adopting the recommendations for consumable LRUs does not guarantee that DLA will pick up every consumable LRU in its inventory. However, missing, incorrect, or unavailable data make construction of "perfect" consumable LRU files virtually impossible no matter what method is tried.

The fact that consumable LRUs are important does not make consumable repair parts unimportant. Placing emphasis on consumable LRUs does not relieve DLA of the responsibility to also seek better ways to support intermediate- and depot-level repair activities. (Recommendation 5 applies here.) In any case, by using the LRU factors suggested in Recommendation 3 to adjust safety levels, DLA can focus on consumable LRUs without reducing repair part safety levels "too much."

Tracking Retail Data

Recommendation 5, to track retail stockage locations and pass that information to requesting sites when high-priority requisitions cannot be filled, is motivated by data from the Army, Navy, and Air Force showing that most of the high-priority [e.g., mission capability (MICAP)-type] requisitions DLA receives come from retail sites that do not stock the particular items requested. The recommendation, of course, applies to *any* high-priority due-out, whether or not the requesting site happens to stock the item. The goal is to shorten the time it takes to fill high-priority, readiness-affecting due-outs whenever and wherever they occur.

Recommendation 5 is consistent with emerging DoD policy on "total asset visibility." That policy calls for DLA to be tied into the Service systems that already exist or are under development to support intra-Service lateral resupply [e.g., Virtual Master Stock Item Record (VMSIR) in the Navy, MICAP Asset Sourcing System (MASS) in the Air Force, and Objective Supply Capability (OSC) in the Army], as well as the DoD-wide Defense Program for the Reutilization of Assets (DEPRA) system for disposing of excess assets. As the manager of many common items used

across the Services, DLA could provide useful *inter*-Service visibility by establishing the recommended capabilities.

System Safety Levels

Recommendation 6 calls for a review of the methods used to perform *system* safety level calculations at DLA's four hardware centers. Those methods are well established in DoD supply practice, documented in SAMMS, and in compliance with long-standing DoD-wide supply policy. The problem is that they appear to be inefficient in the way they are being implemented at DLA.

At the Defense General Supply Center (DGSC) in March 1992, the aggregate safety level requirement in SAMMS was over $300 million, with *more* than 2.0 million expected outstanding unit backorders. Actual outstanding unit backorders at DGSC at the end of March 1992 were more than 3.0 million. (To emphasize, the discussion here is about backordered *units*, not backordered requisitions.)

By recalculating system safety levels for DGSC's full system of 106,000 items (using a revised, *unit*-oriented system backorder target and reapplying standard limits on safety levels), it is possible to obtain an aggregate safety level requirement at DGSC of $54 million, with *fewer* than 2.0 million expected outstanding unit backorders.

The Defense Logistics Agency has asked LMI to conduct the review called for in Recommendation 6. LMI will propose new system backorder targets for the centers. It will also evaluate whether using unit backorders in lieu of line backorders in system safety level calculations will "buy too many cheap items." LMI will also examine the effect on traditional supply measures (line availability and line backorders) if the centers switch to unit backorders when setting system performance targets.

Recommendation 7, to group WSSP and non-WSSP items separately when computing system safety levels, is motivated by the fact that DLA currently trades off WSSP items against non-WSSP items in its calculations. One way or another, however, weapon-system items are going to receive special attention under the new policies emerging for secondary item management. Grouping WSSP items together

for system safety level calculations is a feasible and practical way for DLA to proceed in accordance with the new policies.

Recommendation 7 is straightforward to implement: no new computational algorithms are required. The only change is that – instead of system calculations being done on a single large group of items (WSSP and non-WSSP items together) – they will be done on WSSP and non-WSSP items separately. Initially, that will involve grouping WSSP and non-WSSP items separately at each commodity center. Ultimately, as DLA consolidates inventory control point (ICP) functions, *all* WSSP items should be placed together in a single group when weapon-system safety levels are computed.

If DLA adopts Recommendation 7, managers will have to make a macro-level resource allocation decision they have not had to make in the past: they will have to decide what the budget should be for WSSP items and what it should be for non-WSSP items. In the past, with all items thrown together in a single system calculation for an entire center, that decision has been "handled" at the micro level. Item essentiality codes have been used to try to distinguish between items that, from a weapon-system-support perspective, had no business being in the same group in the first place. In transition, as a practical way to proceed, the current dollar amounts allocated to WSSP items could serve as the WSSP budget and similarly for non-WSSP items.

Proper resource allocation decisions will be important if DLA is to avoid "overdoing it" for weapon-system items and not allocating enough funding for other materiel. Given the new missions DoD is being asked to perform, it is possible that proper supply support for items that do not apply to weapon systems will be as important as support for items that do.

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As DoD's primary wholesale supplier and manager of consumable hardware items, DLA can improve its contribution to weapon-system readiness while still controlling inventory costs. Improvements are possible in two key areas: (1) in the identification and management of first-indenture weapon-system consumables and (2) in the treatment of all DLA-managed items (weapon-system and otherwise without regard to indenture) when wholesale safety level requirements are computed.

First-indenture consumables can be identified by combining two standard DoD logistics data elements: Source, Maintenance, and Recoverability codes and Logistics Support Analysis Record indenture codes. Statistical analysis shows that the relative frequency of weapon-system-grounding items among first-indenture consumables is significantly greater than the relative frequency of grounding items among the population of consumables at large. That, together with indications that first-indenture items represent less than 10 percent of the total number of items DLA manages, suggests DLA can reduce inventory requirements for many items without adversely affecting readiness.

When performing system calculations to determine wholesale safety level requirements, DLA groups items into the commodity categories of industrial, electronic, construction, and general items. That maximizes opportunities for minimizing inventory costs. However, weapon-system management initiatives call for items to be grouped by weapon system when computing stockage requirements. The problem for DLA is to find the right balance between large-scale system optimization and the benefits of weapon-system grouping. Quantitative results for the Defense General Supply Center suggest that by simply distinguishing between weapon-system items and non-weapon-system items when computing requirements, DLA can accommodate the move to weapon-system-oriented management while preserving the cost savings and performance benefits of large-scale optimization.

14. SUBJECT TERMS availability, common components, consumables, Corporate Information Management, DLA, Defense Logistics Agency, EOQ, economic order quantity, inventory, inventory management, item essentiality, readiness, readiness-based sparing, safety level, secondary item weapon system management, sparing-to-availability, supply, supply model, variable safety level, weapon-system support

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